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Technology Review

How Clean a Car?

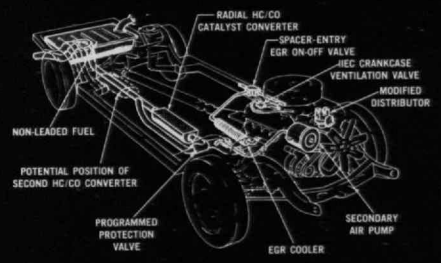
John B. Heywood
Associate Professor of Mechanical Engineering, M.I.T.

The tortuous path of automotive pollution control reaches a climax in 1975. For the first time in history, Congress has written into law specific emission standards—a 90 per cent reduction in emissions from the 1970-model-year cars, which already have some degree of emission control—and they are to be effective with cars produced in that year. Environmentalists view these developments as a legislative triumph, while the automobile industry interprets them as a disaster which makes an already difficult task almost impossible.

To resolve these views, we must answer two vital questions: Just how clean a car do we really need, and how will we know when we have it? And can a car be made that clean in the time available?

The Nature of the Problem

The story of automotive pollution control begins in Los Angeles in the early 1940s', when there first became evident a white smog which reduced visibility and caused eye irritation. A local program to reduce dust and fume emissions from stationary sources did not alleviate the smog proportionately.



Within a decade Professor A. J. Haagen-Smit demonstrated with laboratory experiments at the California Institute of Technology that the smog resulted from the release of large quantities of hydrocarbons (HC) and nitrogen oxides (NO_x). Before these gases were fully dispersed they underwent a photochemical reaction—one where the energy to initiate the reaction comes from sunlight—and formed oxidants in small but nonetheless hazardous amounts. Estimates showed that in the Los Angeles basin the dominant source of hydrocarbons and nitrogen oxides was the automobile. It still is today.

Technology and the Future Growth of International Organizations

Eugene B. Skolnikoff
Chairman of the Department of Political Science, M.I.T.

In any attempt to foresee the large-scale effects of new technology, there is always the temptation to take a cataclysmic view of the future, and to predict dire consequences if major political changes are not immediately made. Such an approach, of which there are many examples in the literature today, rarely leads to useful prescriptions for action. What is requried is a sober examination in detail of the implications of technology for international political action, in order to bring the policy requirements into reasonable focus.

Such an approach is not adequate if, in fact, the technical situation really does imply catastrophe around the next corner. In my judgment, the facts imply not catastrophe, but uncertainty. The first need is to understand very much better our global environment and the effects of our technologically-related insults to that environment; only then will we know whether cataclysm is in the offing, and if so what must be done about it.

Twenty Different Ways to Build a Covered Bridge

Raymond E. Wilson

Though covered bridges form a colorful link to America's past, readers of *Technology Review* may be surprised to learn that this structural form is neither unique to the New World nor original in it. Indeed,

Biological Control and a Remodeled Pest Control Technology

Carl B. Huffaker
Director, International Center for Biological Control
University of California, Berkeley and Riverside

Two pervading developments, meeting in human affairs, bring to public attention little-recognized methods of pest control and the urgency of remodeling current strategies and attitudes if insect depredations are to be controlled without serious environmental effects. A worldwide human population explosion that requires the feeding of ever larger numbers of people, and the largely consequent worldwide pollution of the environment, pose the need to solve the first problem without adding to the second. While man is indeed an earth pest, threatening the ecological base—productive soil, clean air, and clean water—that sustains life, the means by which we may limit his numbers are beyond the scope of this article. But there are methods of pest control that may solve the short-term problem of food production without adding to environmental degradation, thus buying time while a solution to the overriding problem is sought.

Advances in farming technology in this century have been monumental. Crop varieties have been much improved; technologies of pest control, cultivation, fertilization, irrigation, and harvesting of crops have added billions of pounds of food for the world's hungry. Yet weeds, insects, plant diseases, and rodents still claim substantial portions of potential yields.

Following the dramatic successes with DDT and other synthetic insecticides subsequent to World War II, control of insect pests entered an era of unilateral use of those chemicals that killed the most kinds of pests (broad-spectrum effects) and in greatest numbers, with little regard for other effects. The strategy was one of reducing each pest as it appeared, in single-purpose fashion. Clearly, this approach has had tremendous adverse effects on the quality of the environment. Official and public warnings from many quarters have not reduced the use of such chemicals. Rather, pesticide use in the United States has more than doubled in the last ten years, to about one billion pounds per year. Use of these chemicals has not even had the prolonged direct success in the control of the pests themselves that was first indicated. Insect problems have not lessened; they are greater than before.

Many entomologists appeared to feel that the spray gun was the answer to every problem. We learned, in time, that organisms may counterattack and develop resistance to toxicants used against them, but it was thought that another pill could be ready when one no longer sufficed. We are now painfully aware that this is not so. Some species have become resistant or tolerant faster than new materials can be developed. More materials and heavier usage have induced new problems.

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The First Line

When Jerome B. Wiesner first spoke to the faculty of the Massachusetts Institute of Technology as the Institute's President-Elect this spring, he said his purpose as President would be to direct the institution to "continue to deserve [its] reputation for leadership in education, research, and public service."

As Dr. Wiesner knows, there are many sources of a university's greatness, and no one will assure success without the others. Financial strength, sensitive management, diversity, adequate physical plant, effective supporting personnel, high caliber students—all are vital. But the cornerstone is the faculty: without an outstandingly able body of teachers—who are, at least in a technological institution, professionals in the fullest sense—the rest can exist (if at all) only as a hollow shell.

Karl T. Compton, the distinguished physicist who was President of M.I.T. from 1930 to 1949, knew this. Even in 1939 he noted the engineers' increasing opportunities to be "unprofessional," and he stressed the need to resist these temptations.

The warning is just as pertinent today. Professionals are still distinguished by their selflessness, by their abilities to think clearly, to communicate effectively, to separate the relevant from the irrelevant, to organize results, to move from theory toward practice, to recognize uncertainty—in short, to be rational, well-informed, tolerant, and so win the understanding and confidence of their colleagues.

President Wiesner's most important single task will be to identify such professionals and to bring them to Cambridge or keep them here. In no other way can he more surely effect the Institute's future leadership. The task will not be made easier by the necessity to apply such criteria to the Institute's present community. Two recent developments (not entirely unrelated) suggest the dimensions of the problem.

◇ A faculty committee, investigating events connected with the occupation of the offices of the President and Chairman in January, 1970, has reported itself "unanimously of the view that [these events were] conduct wholly intolerable in an academic community"; and it also reports "no [serious doubt] that one or more members of the academic staff directly participated in the occupation . . ."

◇ The debate occasioned this spring when the Philosophy Section of the M.I.T. Department of Humanities petitioned the faculty to support its change in status to an independent department is revealing. Though the result was never in doubt, the disrespect and misunderstanding of M.I.T.'s humanities and professional departments, each for the other, became too clear.

This is not to say that even the ideal university faculty can be uniquely devoted to a single professional purpose; or even that it may have the wisdom to define such a purpose for itself. It is to say, however, that the privileges of tenure must not be taken to include the privilege of being second-rate; and that a faculty must have standards of value which transcend its professional specialties. "The faculty is the university," Julius A. Stratton wrote in his inaugural as M.I.T.s' eleventh President.—J.M.

Eric Hodgins, 1900-1971

Eric Hodgins, whose first excursions into journalism following graduation from M.I.T. in 1922 were as Managing Editor of *Technology Review,* died early this year in New York. He was the author of *Mr. Blandings Builds His Dream House* and *Episode* and—following five years at *Technology Review*—held editorial posts successively with *The Atlantic Monthly, The Youth's Companion, The American Boy, Redbook,* and *Fortune*—of which he was Managing Editor from 1935 to 1937 and Publisher until 1941.

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for
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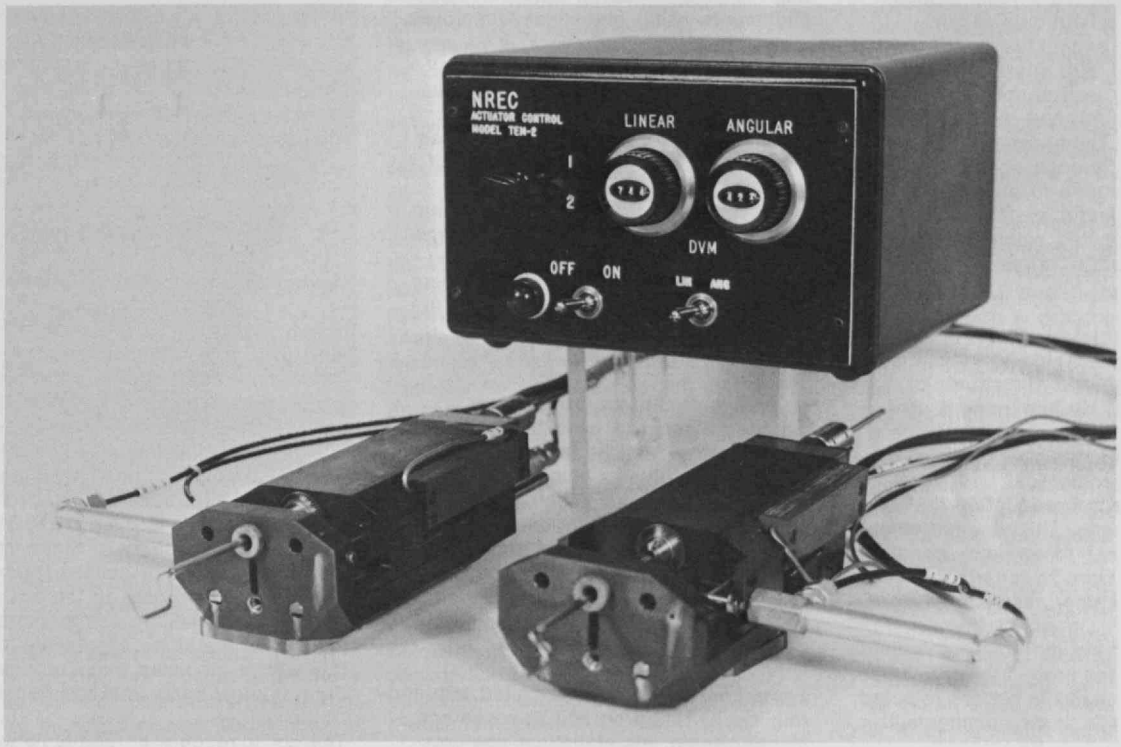
—Lord Kelvin (1824-1907)



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Science Review
Robert C. Cowen

Radiocarbon dating has been readjusted. Suddenly it appears that ancient Europeans built stone tombs and developed metallurgy before their presumed mentors had begun. Here is an account of new findings "which suggest unsuspected scientific prowess among supposedly 'primitive' Bronze Age Europeans"

Science in the Bronze Age

When a distinguished scholar brings fresh insight to a field outside his specialty, you'd expect his contribution to be welcomed with interest. Right? Wrong! He may well encounter incomprehension, sneers, and disdain. That's why Alexander Thom, Emeritus Professor of Engineering Science at Oxford, ran a gauntlet of rebuffs to publish his archaeological findings—findings which suggest unsuspected scientific prowess among supposedly "primitive" Bronze Age Europeans.

For decades Professor Thom has tramped the countryside to survey many of Britain's rings and alignments of standing stones. He has found a precision of layout that would challenge a modern surveyor. His data reveal a sophisticated geometrical and astronomical knowledge antedating that of Babylon or Greece. This was too much for archaeologists to swallow, conditioned as they were to regard their Bronze Age ancestors as rude savages.

But gradually the quality of Thom's field work and analyses eroded the resistance. Where once he had his papers rejected with what he calls "rude comments," he has begun to find acceptance. Indeed, today his findings help spur a revolution in our view of Bronze Age Europe.

Recent adjustments in radiocarbon dates show that many of Europe's Bronze Age advances in fact predate the Oriental civilizations that supposedly inspired them. Europe's archaeologists are changing their whole approach to the past. They are recasting prehistory in terms of ancestors who were the creative equals of Mycenaeans, Egyptians, or Sumerians. And Thom's findings are one of the most striking indicators of those ancestors' intellectual competence.

The Megalithic Yard

When Thom talks about precision layout in the old stone alignments, he means dimensions that reflect precision use of a universal length unit. He means designs worked out according to discoverable geometrical rules. Such features won't jump out at you when you visit a tumbled-down stone ring—of which England has hundreds. Thom has dug his theories out of data on rings and alignments using statistical techniques.

Take a list of accurately measured characteristics, say a set of ring diameters or perimeters. Statistical techniques will show whether or not those dimensions were laid out in terms of a standard length unit. They will also show what that length unit was. Thom calls the basic unit he found the megalithic yard (MY). He calculates it to be 2.720 ft. $\pm$ 0.003 ft. The old rings and alignments, he finds, were laid out in units of the megalithic yard itself or derivatives of it—½ MY, 2 MY, etc.

He also finds that the Bronze Age geometers seem to have been fascinated with integers. Ring perimeters tend to be integral multiples of diameters or of the length unit used. Their designers sometimes distorted circles and ellipses to achieve this. They used constructions based on Pythagorean right triangles, Thom says. He has worked out such constructions himself to show how this could have been done.

Thom has studied the so-called cup-and-ring marks found on British rocks and stones. Again, his statistical analyses have turned up a unit length. It's just 40 times smaller than the megalithic yard used for the full-scale layout. Thom imagines the designers working out their inscriptions using fixed compasses with quartz or flint scribing points set accurately at 1, 1½, 2, 2½, etc., units.

This was more than geometrical exercising. It now seems evident that these Bronze Age scientists were using their rings and alignments to record hard-won astronomical knowledge. Thom identifies many sighting lines in these structures that mark astronomically important azimuths. Two or more stones may define such a line directly. Elsewhere, a stone may mark where to stand to use a well-shaped peak or a notch in a hill as a natural foresight on the horizon. The setting sun, for example, might graze such a "foresight" at the summer solstice.

Of course, no one can prove the ancients did use their stone layouts in this manner. However, Thom has shown that the structures do define sight lines that could have been used with an accuracy of a minute of arc for important practical purposes. Some of the layouts could have been used to maintain an accurate calendar dividing the year into 16 roughly equal months. Others could have been used for detailed study of the orbital motions of the moon with an eye to eclipse prediction.

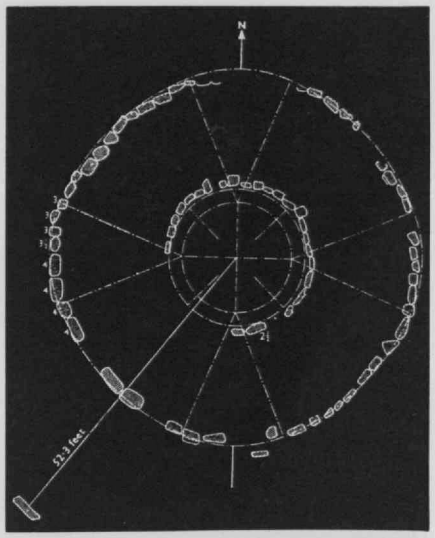
Predicting Lunar "Danger Periods"

As the moon swings through its orbit, its declination (angular distance from the equator) hits a maximum once a month. Since the moon's setting point along the horizon depends on declination, this too moves between a monthly maximum and minimum northwesterly azimuth. Also, this monthly maximum itself varies between extreme and intermediate values over an 18.61-year period. Detailed study of these variations could set you up for eclipse forecasting. Thom has shown how, in the era around 1800 B.C., megalithic astronomers could have used the stone alignments to do this with a precision that Europeans did not know again until the Renaissance.

There's a roughly 5° angle between the moon's orbit around Earth and Earth's orbit around the sun. This angle, while generally stable, undergoes a periodic fluctuation of $\pm$9 min. every 173.3 days. Tycho Brahe, the sixteenth-century Danish astronomer, picked out this 9-min. wobble in lunar declination and showed that it marks the middle of eclipse "danger" periods. The orbital dynamics are such that a new moon occurring within such a period may eclipse the sun. And a full moon occurring within a danger period probably will be eclipsed. Some of Thom's sight lines mark (for megalithic times) the most northerly setting of the moon when the peak of the 9-min. wobble was superimposed on the greatest declination of the 18.61-year cycle.

If we were studying this kind of lunar motion today, we probably would plot nightly observations on graph paper. The exact time when the moon reached its greatest declination, or its most northerly point, probably would occur between successive observations of

Britain is spotted with remnants of ancient stone rings which predate the far more complex and famous structure at Stonehenge. Alexander Thom proposes that they prove for their builders a sophisticated sense of geometry and astronomy which has never before been attributed to Bronze Age men. (Drawing: Thom, Megalithic Sites in Britain *from* Nature*)*



moonset. By plotting a run of observations, you could easily pick out the exact moment of the maximum. Thom has worked out a method by which megalithic observers could have done this by plotting the observations with stakes driven into the ground. Some sites also have remains of a grid-like pattern of standing stones. Thom has worked out a way by which these could have been used to calculate the extrapolation. Here again, he can't prove that the patterns were used for this purpose. But if the ancients thought like Thom thinks today, they could have used those stones as a calculating grid.

While Thom has worked out all of this from a lifetime study of British sites, the scientific culture it suggests was probably spread widely through Europe. Other studies, inspired by his work, have found evidence of the megalithic yard in Germany. And Thom himself now is moving onto the continent to find this unit in Brittany. He's been studying the famous alignments and associated rings near Carnac. There, over 2,700 stones march in line, 10 to 13 abreast, for over two miles in three sections. Already, Thom has found the alignments were laid out in terms of what he calls the megalithic rod (2½ MY).

As in Britain, you can't measure this directly. You have to pull it out statistically. The stones are pushed about. There's a ploughed-up area in the middle of the alignment. Nevertheless, Thom says he hasn't "the slightest doubt whatsoever" that the alignments are laid out in terms of the megalithic rod and laid out to an accuracy of one part in 2,000. That's an accuracy where, in modern surveying, you would have to take account of the expansion of steel measuring tape when the sun hits it.

Then there's Le Grand Menhir Brisé at Locmariaquer near Carnac. It's a broken 340-ton stone that would have stood at least 67 ft. tall in megalithic times. It would have been visible from all over the Carnac area, so Thom thinks it was a universal astronomical foresight. He's already identified several possible backsights marked in stone from which the menhir would have defined an astronomically significant azimuth. He's even found stone alignments that he thinks might have been used as a calculating grid in astronomical observations.

Radiocarbon Readjusted

As Colin Renfrew of the University of Sheffield, one of the leading prophets of the new outlook, explained recently, the three foundation pillars of diffusionism were shattered in one blow when radiocarbon dating was readjusted. These three theoretical props were the assumed spread of monumental tombs from the Aegean to Spain and thence to France, the diffusion of metallurgy into the Balkans, and the entrance of Mycenaean influence into Bronze Age Britain. Suffice it to say that, for the period in question, the radiocarbon adjustment has shown the dating of relevant European sites to have been too young by 700 to 1,000 years. Suddenly it appears that ancient Europeans built stone tombs and developed metallurgy before their presumed mentors had begun. The supposed Mycenaean influence in Britain predates Mycenaean civilization itself. European archaeologists, Renfrew observes, now have to find "an explanation in European terms for what took place in Europe." So Thom's speculations about Bronze Age "scientists" don't seem so far out after all.

Thom himself makes no claim to archaeological competence. He has faith in his skill as a surveyor. He believes in his statistics and what they show objectively, such as the existence of the megalithic yard. Any thoughts he has on the Bronze Age society that built the monuments he offers only as an amateur's speculations. With this reservation, he thinks in terms of a widespread scientific culture with very ancient roots. It would have taken hundreds, probably thousands, of years to develop the astronomical knowledge finally embodied in the stone alignments. It would have taken widespread, if loose, cooperation to maintain the megalithic yard and its precision of use. Length standards developed locally would vary. Even to copy locally a standard sent from place to place would have introduced detectable errors. More likely, measuring rods were distributed from one or a few factories, centers at which astronomical observers and geometers may also have been trained. Perhaps the Carnac area had such a "bureau of standards." Brittany now seems to have been a center from which at least some aspects of megalithic culture spread. The vaulted stone tombs there now are known to be the oldest stone buildings yet found in the world.

Colin Renfrew agrees that Thom's findings suggest wide European interaction on the "scientific" level. But he warns that we can see only dimly what kind of society this suggests. The importance of what Thom is doing, he says, lies in providing high quality field work and statistical analyses that make you think in new terms. He gives archaeologists "something you can get your teeth into." Renfrew thinks Thom's case for the megalithic yard is well established. But he has doubts about some of the astronomical sighting lines.

A. J. Hogg of the Welsh Ancient Monuments Commission, on the other hand, accepts the astronomical arguments. He feels uncomfortable about the megalithic yard and Pythagorean geometry. Glynn Daniel, dean of Britain's megalithic experts, wryly notes that "trying to explain these phenomena [Thom's findings] as repeated accidents is even more improbable than accepting the admittedly unexpected conclusions."

Thom himself says he doesn't "blame them for considering me a nut. Here I was coming at them with wild ideas and strange mathematics. Of course they should have treated me with caution. I know how they felt. Now I've got a lot of nuts bothering me with crazy alignments and I'm sick of them." The moral, I guess, is that, if you think you've got special insight into a foreign field, you better have an arsenal of data to back up your "nutty" suggestions and a heck of a lot of persistence—in this case a lifetime's worth.

Robert C. Cowen, Science Editor of the Christian Science Monitor, *graduated from M.I.T. in meteorology in 1948. He has been stationed in London until early last month, and he will henceforth write for* Technology Review *from Washington, D.C.*

Washington Report
Victor Cohn

What the National Academy of Sciences does in the near future "will deeply affect America's view of scientists and technologists, and thus its use of their knowledge in attacking its terrible agonies." Hence the significance of the turmoil now surrounding its stately domicile on Constitution Avenue

The "House of Lords" of Science

The creamy white edifice at 2100 Constitution Avenue is one of Washington's stateliest piles. It is austere, august and solid, and the inscription carved into its rich marble—"NATIONAL ACADEMY OF SCIENCES"—says to the knowing, "This is the House of Lords of American science."

The Academy is in fact the most elite body in U.S. science; it is by Congressional charter adviser to government, and it consists of 900 members who annually augment their own ranks on the basis of research achievement and a little favoritism. They enlist hundreds of others in the committees and study panels of the National Research Council, the main operating arm of the Academy. Together, N.A.S. and N.R.C. comprise what is collectively known as "the Academy."

The Academy is today at peak demand as federal adviser. It is also in trouble. It is in demand by the White House, executive agencies and Congress. "Congress," *Science* said recently, "looks on the Academy as a competent, independent scientific authority, perhaps the only one around."

Congress last year designated the Academy and not a government agency to monitor automobile manufacturers' progress against air pollution. Last year's Defense Appropriation Act ordered the Pentagon to contract with the Academy for long-range study of herbicides' effects on the Vietnamese land and people.

Academy panels are either probing or getting ready to probe a growing list of what the *National Journal* recently called technological "hot potatoes." The issue of nuclear radiation standards is on this list. So—on the Academy's own initiative, which is increasing—are power plant siting, the roots of heroin addiction, and the nation's feelings about law and order.

An Academy panel advised the Atomic Energy Commission that it could safely deposit future radioactive wastes in a Kansas salt mine. Another helped the under-staffed Food and Drug Administration decide which of 2,800 common drugs, many of them big items in the pharmaceutical industry, are actually of dubious value or useless. Another told the Transportation Department that an S.S.T. fleet might affect the earths' radiation shield and cause a worldwide increase in skin cancer—an assessment disclosed late in the S.S.T. fight.

Scientific Power, Political Puppet?

The Academy, then, is a technological-political power. But it is a power in jeopardy. An important share of the public now looks with high suspicion on too cozy an alliance between science and government. A small but growing number of scientists think serving whatever administration may be in office is not necessarily the same as serving "the people."

Is this some kind of hippie view? Former Interior Secretary Stewart Udall, no hippie, last December called the Academy "a virtual puppet of government" and its members "political eunuchs" for their customarily polite and conservative role.

Ralph Nader—per a suggestion by Udall, privately seconded by one of *Science* magazine's star reporters, Philip M. Boffey—has started an investigation of the Academy's roles. The investigation is being conducted by Mr. Boffey—who, in one of his last assignments before leaving *Science,* dubbed the Academy U.S. science's "House of Lords."

What will Boffey find? He will certainly find elitism, over-secrecy and conflict of interest. Academy panels have too often been top-heavy with members employed by or financially beholden to the interests they are supposed to judge. "It's true," Academy (and Harvard) official Harvey Brooks told the *National Journal,* "that some of our bodies—the Highway Research Board, Food and Nutrition Board and Space Science Board, for instance—may be constituted too completely with those who have an economic or institutional interest in the outcome of their work."

Drug, pesticide and building industry panels may be equally guilty. A radiation panel was enlarged recently to try to meet just such criticism.

When Is Private Public?

One problem has been lack of much public scrutiny—the kind Nader *cum* Boffey are now attempting—of Academy workings. Some Academy reports have either been buried by the agencies that bought them or kept locked up until public interest was dead.

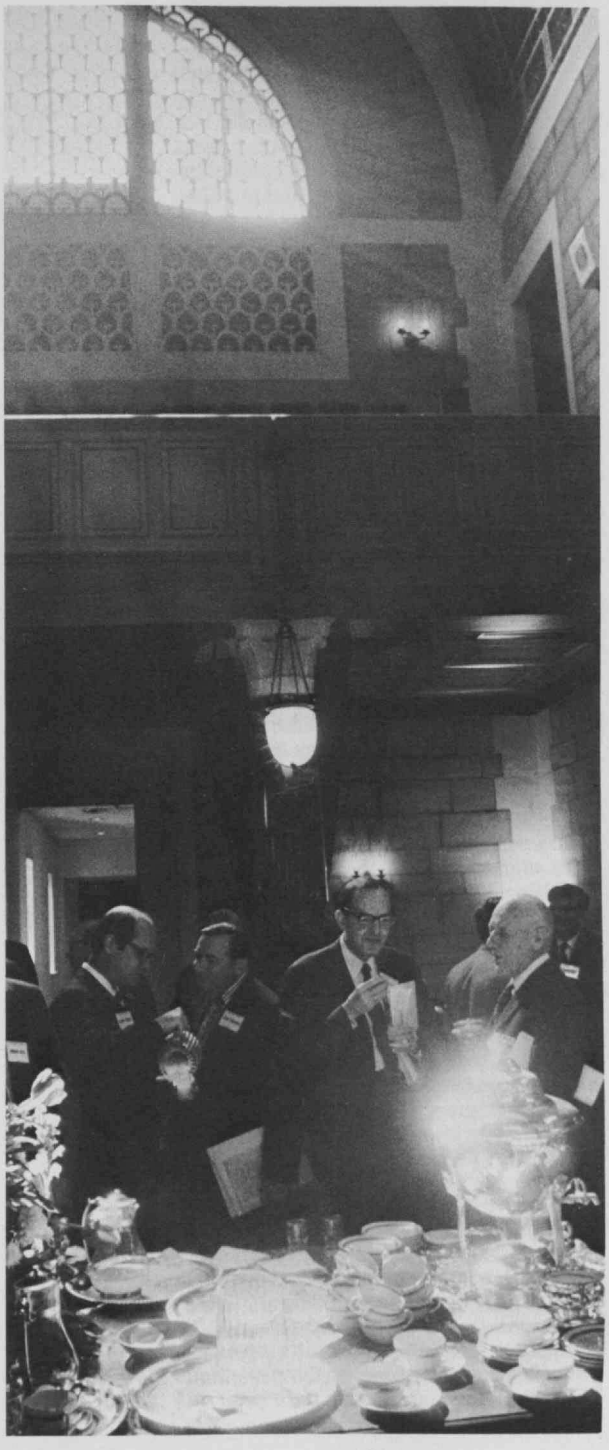
Academy business does not become public business unless and until the Academy chooses, despite the fact that all but a few million of its $33 million annual budget comes from the public purse, in payments for studies. This year an Academy panel completed a report advocating extended national research on heredity and human performance. This is an explosive topic, for it involves weighing the validity, meaning and implication of the disturbing finding that black children lag on the average in IQ tests.

By Academy policy, it was stated, the report would not be made available to the public unless it were "accepted," though it was written by eight of the country's leading social and behavioral scientists. As it happened, the contents were publicized in advance by a newspaper reporter. The Academy at its annual meeting in April voted to reject the report's main recommendations (while agreeing on "closer cooperation" among scientists to contribute to broader training and research). The full report then was made public—but might not have been had it not been for the unusual amount of press inquiry, whetted by the fact that the Academicians were meeting, as usual, behind closed doors.

The American Medical Association, to its credit, has held its semi-annual House of Delegates and important reference committee meetings in public view for years. The American Association for the Advancement of Science, pressed by reporters, has similarly opened the doors to its annual council meeting.

Legally speaking, Academy members may be joining a "private" organization. But, whether they like it or not, they also are public men. And public men keep the public more in mind when they must operate in public view.

In the morning preceding its annual meeting, the National Academy of Sciences sets its Washington rotunda with an elegant table of coffee, tea, and pastries to greet members returning from throughout the U.S. A visitor senses instantly that one of the world's principal scientific sodalities is in residence. (Photo: Mark Handler from the National Academy of Sciences)



This fact may take some sinking in for a group whose average age is 62, with 25 per cent of all members 70 or older. The members in April turned down a proposal that they be made "emeritus" at age 75. The inflexibility of some of the old is a constant problem for Academy officials, though they cover it with a few sighs and an appearance of patience.

One impatient Academy youth—Dr. Richard Lewontin, 42, University of Chicago mathematical geneticist—resigned on April 28, however, in the group's first political resignation in a century. He quit because the Academy does classified studies for the military (2 to 4 per cent of its work) which he could not see. The charter, he argued, makes all members responsible for Academy acts, and "it must be a first rule of life that those who are responsible must be allowed to know what they are responsible for."

Lewontin's departure was also related to disgust with the current fruit of military research: technological war in the East against "unwilling victims of American national self-interest." Here he found much agreement, yet most members sided with Dr. George Kistiakowsky of Harvard, who said:

"I resigned from all connection with the Defense Department in 1967 as a protest against the war in Vietnam. I personally feel the military has acquired too much political power in the country. But to deny work which is involved in the defense of the country is deeply wrong. That is our duty as citizens."

Improving the Opportunities of Science

It is as citizens, of course, that Academy members increasingly will be judged. No one is more aware of this than Dr. Philip Handler, the sensitive, almost shy, yet hard-driving, ambitious biochemist who became Academy President in 1969.

He has pledged that Academy reports, as new ones are negotiated, will no longer be buryable. He has pledged to balance study panel members who have close industry ties—which cannot be completely avoided in picking experts—with those who have none.

In a recent interview, he pointed to three "major accomplishments" so far: persuading the group to admit the first substantial numbers of behavioral and social scientists and research physicians, starting next year; creating a review committee under Kistiakowsky for better quality control of Academy work; and some moves toward a true working relationship with the National Academy of Engineering.

He described two more major goals. One is establishing better control of "the projects we undertake," to eliminate the trivial. The other is "improving the mechanisms by which the Academy can come to grips with the broad area of science policy."

It is in discussing this last goal that Handler, the leader, burns brightest:

"Scientists and science itself have been called into question in our time. It is not clear that the American people will be willing to support science on the scale we have shown. It is not clear that young people will aspire to do science. Yet it is clear to me that the possibilities and frontiers of science are as exciting as ever.

"I don't mean for us to be a lobby, but that we must grapple with why these things are true, and in some decent, dignified way use our resources to improve the public image of science—to convey our sense of excitement and great potential to the public, including those who appropriate funds."

The present public image of science, he knows, can be improved only if scientists do the right public things. What the Academy does in the near future will deeply affect America's view of scientists and technologists, thus its use of their knowledge in attacking its terrible agonies.

Victor Cohn, who writes regularly for Technology Review, *is Science Editor of the* Washington Post.

European Report
William H. Jahsman

The European community's efforts to join together its resources and knowledge in support of major scientific efforts have a counterpart in the development of Europe-wide societies in which both eastern and western professionals are joining. The result may be a new third power in international science

Toward a European Scientific Power

Although a Euromart of Science and Technology may never achieve official status, the trend toward cooperation on engineering and scientific projects and toward formation of inter-European-national professional societies is clear. Just as the universities are drawing together in consequence of student and faculty pressures for reform, as I described in the first article in this pair (Technology Review *for May, pp. 6-7*), so too—for very different reasons—are the professionals.

Some of the organizations which have developed out of international scientific efforts are well known: the cooperatives such as CERN for nuclear research and E.S.R.O. for space exploration, and the engineering projects like Concorde, the Anglo-French S.S.T., and the European airbus under joint development by England and Germany (*see* Technology Review *for February, 1969, pp. 10-11 and for July/August, 1970, pp. 8-9.)*

Less publicized but equally significant is the appearance of a number of inter-European-national scientific and engineering societies. Probably the best example is the recently formed European Physical Society. Another example of cooperation is the series of annual scientific exchanges arranged between such societies as the Royal Aeronautical Society and the Deutsche Gesellschaft für Luft und Raumfahrt; these exchange programs may well lead to more official Anglo-German engineering organizations in the future.

At least two factors militate against any runaway growth of such cooperative ventures. National interests and scientists' individual national loyalties are the obvious depressants. But the heterogeneity of educational systems in Europe is also an important natural barrier. Curricula differ not only in course content but also in the highest degree awarded. These factors are changing, as I suggested in the earlier article; but the process is at best slow, spasmodic, and in detail unpredictable.

For many years to come, cooperation between eastern and western European countries will be focussed principally on the professional societies. Engineering and scientific projects often have strong elements of national pride, and many today require substantial financial backing. Problems of currency exchange complicate any cooperative venture. One need only recall that the relatively straightforward plan to license manufacturing rights for Fiat vehicles in Poland required years of negotiation.

The development of professional societies is being pursued with equal vigor by both eastern and western scientists and engineers. For the eastern group, permission to pursue such objectives represents an enlightened and liberalized governmental attitude. Polarization of technical thought may well result, eventually leading to projects currently regarded as unrealistic. At that point, a viable third power in science and technology will have emerged, one which will provide healthy competition to the other two powers in the Western Hemisphere.

Engineering and Scientific Projects

The European Space Research Organization is probably the best example of multiple-nation cooperation. Established eight years ago, it is composed of ten member nations (Belgium, Denmark, France, West Germany, Great Britain, Italy, the Netherlands, Spain, Sweden, and Switzerland) and two observers (Austria and Norway). It is subdivided into four huge directorates: Programs and Planning, and Administration, both in Paris; European Space Operations, in Darmstadt, Germany; and the European Space Research and Technology Center (E.S.T.E.C.), in Noordwijk, the Netherlands.

E.S.T.E.C., which has evolved from originally independent research and engineering departments created early in E.S.R.O.'s career, is the most important of the directorates. It is responsible for design, development, and construction of all sounding rockets and satellites used by E.S.R.O. for scientific measurements in space. Four satellites have already been placed into orbit using U.S. launching sites and boosters: ESRO I and IB, to measure ionospheric phenomena; ESRO II, to measure solar radiation; and HEOS I, to measure magnetic fields and solar winds. Near-future launches include the ESRO IV and HEOS II, the latter to be injected into a highly elliptical polar orbit to reach the neutral sheet separating the terrestrial and interplanetary magnetic fields. By far the most ambitious project is the half-ton TD I astrophysical satellite with a projected launch date of late 1972.

My visit to the three-million-square-foot E.S.T.E.C. complex (protected from a brooding North Sea by natural sand banks) was limited to the environmental testing laboratories. These are located in one of the three main wings of the complex and are used for testing of both components and complete satellite assemblies. The tour included visits to the mechanical test facilities, space simulation chambers, and qualification and reliability testing rooms for both materials and devices. Care in the selection and operation of the equipment for the different testing areas was evident; for example, even though mechanical vibrators with capacities ranging from 0.5 to 14 tons are located in the same bay with the solar simulation chambers, they can be operated on their seismically isolated mounts without interfering with thermal soak tests which may be going on simultaneously.

A separate area is used for the qualification tests on materials and devices. Here engineers point proudly to the television X-ray scanning device used in failure detection and diagnosis and to the Stereoscan electron microscope used for high magnification three-dimensional inspection of transistors and other components.

Minute records are kept on all components used for the various projects. As a consequence, data storage, processing, and retrieval represents a large adjunct to the main business of testing.

Test records must be kept in case malfunctions occur during the development phase of a space project. A substantial room adjacent to the mechanical and thermal test facilities is filling rapidly with tapes, and other data are stored in Darmstadt. Fearing the spectre of overflow, the engineers are seeking methods of discarding unnecessary data prior to storage.

E.S.R.O. scientists and engineers can be proud of their accomplishments. The increasingly sophisticated sequence of satellites which have been placed in orbit have all met performance specifications, and even more ambitious plans for applications satellites (meteorology, navigation, communication, etc.) are already under way.

Can similar success soon bless E.S.R.O.'s sister organization E.L.D.O., the European Launcher Development Organization? Established to provide boosters for eventual use with E.S.R.O. satellites, E.L.D.O. holds the unenviable record of no complete successes in five launch attempts. There may be something to be learned in examining the organizational differences of these two: in contrast with E.S.R.O., which conducts its programs through the directorates, E.L.D.O. has assigned responsibility for the various stages of the launch vehicle to individual nations. Thus the outcome of a project depends crucially on the financial ability and technical know-how of the country assigned. (This contrasts with the E.S.R.O. arrangement, where the directorates utilize the international expertise of the specialists supplied by the member nations. The international quality of E.S.T.E.C. was quite apparent during my visit, with Dutch-, French-, German-, and English-speaking scientists all within earshot during the tour.)

Comparison of the cooperative E.S.R.O. approach with the collaborative one of E.L.D.O. suggests that the common goals of the European Space Community may best be served if these two organizations are merged (a subject now under discussion by the scientific council ministers). But this will imply subordination of national aspirations—a philosophy only slightly less than heresy to a state minister. However, should such a merger develop, the proud statement by E.S.R.O. that ". . . the complexity of the projects [is] steadily growing to a level where Europe need no longer play *second fiddle (*italics mine) to other space powers . . ." will have to be taken more seriously.

Professional Societies

Operating out of the public spotlight, national and international professional societies may often represent a more accurate picture of government attitudes toward science and engineering than any day-to-day pronouncements or actions. Thus it must be particularly gratifying to European scientists to see evidence of willingness on the part of eastern as well as western nations to allow the formation of such professional societies.

A good example was set two years ago by the physicists, who formed the European Physical Society. At that time participating countries included Czechoslovakia, England, France, Germany, Hungary, Italy, Poland, Rumania, Switzerland, and Yugoslavia.

Now murmurs are being heard from members of the European mechanics community that the time has come for a comparable organization in theoretical and applied mechanics (my specialty, naturally). A leading contender to become the nucleus of such a society is the Euromech group. Officially established in 1967 for the sole purpose of arranging informal colloquia on specialized topics in fluid and solid mechanics, this group has found a ready acceptance for these meetings, which are now running at a rate of six per year.

Colloquia are organized with a minimum of administration, a model well worth emulating by efficiency-minded professional societies all over the world. General planning is carried out by a committee of members selected by participating countries. The committee determines colloquium topics and chairmen, the latter on the basis of their ability to provide surroundings conducive to a healthy exchange of ideas. Once selected, the chairman has full authority to choose the participants and format of the colloquium. Attendance is small because of the narrow specialization, usually less than 50. Ample time is provided for discussion, and participants have the opportunity to become personally as well as professionally acquainted. Costs are minimal, since meetings are held in universities where lodging and meeting facility expenses are low, and participants are generally expected to find financial assistance from outside sources to cover travel expenses. No formal proceedings are published at present, since it is anticipated that authors will seek publication in the scientific journals of their choice.

It would be relatively easy to use the Euromech organization as a base for a "European Mechanics Society" (my title). Contacts with most of the candidate countries have already been established (past colloquia have been held in Berlin, England, Germany, France, Poland, and Czechoslovakia), and Euromech already reports on its activities to I.U.T.A.M., the International Union of Theoretical and Applied Mechanics, which has overall responsibility for international cooperation and coordination. However, some expansion of Euromech personnel would be needed to arrange a mechanics congress on the scale of a U.S. or U.S.S.R. national meeting.

The Gesellschaft für Angewandte Mathematik und Mechanik, with headquarters in Aachen, is typical of larger European societies with considerable prior experience in organizing European congresses on a grand scale. The 1970 annual (April) meeting in Aachen included seven specialty sessions as well as invited lectures on seven topics of current interest, and attracted 540 registrants (large for Europe); a special issue of *Zeitschrift für Angewandte Mathematik und Mechanik* was devoted to publication of the abstracted papers.

While the principal beneficiaries of the G.A.M.M. meetings are the German-speaking scientists, only minor modifications would be required to fully internationalize the meetings. Certainly the organizational powers of the Germans would be useful in the formation of an E.M.S., and undoubtedly many of the G.A.M.M. members would strongly favor leading such an effort—particularly since it would be completely consistent with the Social Democrats' policy of promoting European cooperation in all fields. However, it is likely that a number of countries are not yet ready for this leadership, effective as it may well be.

A late entry into international mechanics organizations is the International Center for Mechanical Sciences in Udine, Italy. Established in 1968 for the purpose of promoting research and exchange of information in mechanical sciences, the center has elegant offices at the Palazzo del Torso, a modest-sized palace in the center of town. Its present activities are concentrated in the summer months when short courses of lectures on a variety of advanced topics in mechanics are held during a six-week session. The remainder of the year is devoted to arranging the next summer program; while a small but efficient secretarial and support staff is available at all times, no permanent scientific staff has yet been attached to the Center. The continuity in scientific administration is maintained at present by its Secretary-General (and guiding spirit), Professor L. Sobrero of the University of Trieste.

Ambitious plans have been laid for future scientific activities at the Center: it has been selected as the site of the First Italian National Congress of Theoretical and Applied Mechanics in 1971, and it will also serve as the meeting place of the 1972 International Conference on Stress Analysis. Both of these meetings will place a real strain on the already cramped facilities, and Sobrero has been investigating two alternatives: use of additional meeting rooms provided by the Udine city fathers (the town hall and municipal building each possess an auditorium, and the combined capacity would be adequate for these meetings); or (a more drastic if more romantic solution) a move of the Center to a site about 25 km. southwest of Udine to the Villa Manin, an eighteenth-century summer retreat for the Venetian doge of the time. Now a trust of the region of Friuli-Venezia Giulia, it is undergoing extensive restoration and renovation (installation of central heating, wiring, and plumbing).

Other candidate organizations could be added to the list; however, the three identified here are probably the leading contenders to spearhead an E.M.S. drive. The English and Italian organizations both offer excellent visibility between Eastern and Western Europe because of the memberships on the governing boards. Additional participation in G.A.M.M. is also likely if Herr Brandt's Östpolitik bears fruit. Both the

(continued on p. 12)

Is it really so bad that technology assessments are always carried out in an environment of emotionalism? Isn't the true purpose of technology to provide the wealth which permits free emotional choices? The issues most in need of assessment are those whose resolution will be only partly technical

Technology: Trying to be Rational

(continued from p. 11)
English and Italian operations would have to be expanded to accommodate correspondence and general business responsibilities associated with an organization of an estimated 500 to 1,000 active members.

Italian enthusiasm is unbounded, and their scenery is unparalleled, but (alas) scientific personnel are lacking. The necessary talent is available in England, but so too is the typical British reserve, and no one yet has taken the initiative. The Germans seem to be well equipped to handle an E.M.S., although a good deal of national spirit would have to be suppressed to attract international support.

Current educational heterogeneities and national loyalties notwithstanding, the trend toward additional European cooperation in science and engineering is a very real one. A major reason is obvious: the human and economic resources which several countries can bring together make possible projects which no single country could accomplish. The collective efforts, while not matching the scale of the projects undertaken in the U.S. or U.S.S.R., may at least approach them, and the collective achievement provides not only the pride of accomplishment but also a sense of independence of the big two powers.

William H. Jahsman is Professor of Mechanical Engineering at the University of Colorado. This is the second of two reports in Technology Review *resulting from his one-year assignment (in 1969-70) to the London Branch of the Office of Naval Research.*

More and more people accept the non-hysterical proposition that the potential impact of a new technology should be investigated fully and publicly before there is a major economic commitment to its use—the idea of "technology assessment."

Also popular is the idea that there hasn't been any technology assessment up to now. Of course this isn't true.

There is a good deal of institutionalized assessment of the efficacy of drugs and of the utility of new materials for construction, both being rather directly linked to two of the major goods provided by a technological civilization: prolongation of life and the prospect of shelter for everyone.

To be sure, the review of these topics carried out by the federal government (in cooperation with the National Academy of Sciences) is narrowly linked to one issue: Does the substance or material perform as claimed? It is well to point out that a lot of the technology assessment of the future will continue to be of this narrow sort. It must not be undervalued; any broader technology assessment will have to rest on this kind of primitive question.

It may be amusing to note that the work of the National Academy of Sciences on drug efficacy and building materials is partly classified and therefore would seem to violate the New Sentimentality. This was brought out in April when one member of the Academy, Dr. Richard C. Lewontin of the University of Chicago, resigned in protest at continuation of a modest amount of classified advice-giving to the U.S. military (*see "Washington Report" by Victor Cohn, pp. 8-9*). Until Dr. Lewontin made an issue out of secrecy, neither he nor Academy officials had thought much about the non-military secrecy. The reason for it is that most U.S. government agencies are not permitted to hold proprietary information of private firms. If a firm tells the Bureau of Standards or the Food and Drug Administration about the contents of a chemical or how something is made, the information becomes public. But the Congressionally-chartered Academy is semi-private, and it can hold proprietary information acquired in the assessment process.

Technology in the Political Arena

On broader questions, a form of technology assessment is already taking place in the political arena. There are more and more arguments about plans to build new highways (bitterly resisted in cities like Boston and San Francisco), downtown skyscrapers (a San Francisco revolt cancelled a huge U.S. Steel project), or new airplanes (Congress cancelled support for an American supersonic airliner, and there is widespread resistance to government-guaranteed loans to Lockheed to assure completion of the L-1011 airbus).

The purist in technology assessment may object to rough-and-ready judgments in the incurably emotional sphere of politics; he argues that rationality has no chance in such an atmosphere. But let the purist consider: most major issues in technology assessment will have to be resolved in the political process.

The point is that most assessments can't be carried out until there is pressure for them. That pressure does not build until an issue becomes visible. As many experts in technology assessment have pointed out, nobody could foresee the vast scale on which DDT would be used when it was first employed in the laundering of soldiers' clothes in World War II as a protection against body lice. Nobody could have foreseen how much DDT would be disseminated—so much that two decades later one gram of DDT is diluted in the body fat of every adult human being on Earth.

Although we may be somewhat better in the future about predicting the scale on which an attractive new technology will be applied, there is no prospect that developments can be suspended until our predictions reach 100 per cent certainty. It may be, for example, that governments will yield to the emotional rhetoric about the dangers of nuclear power plants made by some critics and tighten radiation-release standards, largely because there isn't much penalty in doing so; but the need for the plants is overwhelming—they will be built.

Yet some interesting new concepts are now being forged in the current adversary proceedings about highways, nuclear and conventional power plants, bombers, and buildings.

One result of this rough-and-ready institution-building, is the idea of looking at the full social cost of a new economic commitment. This was the crusher for the U.S. Steel building in San Francisco; Opponents insisted that there be a calculation, not merely of the new taxes that would flow to the city's starved treasury from the building, but also of the new expenses that the city would incur from the dislocation of people, additional pollution from traffic, etc. The result was a cost figure that outweighed the benefits.

To be sure, the technology assessment purist would insist that the opponents were really motivated by a strong emotional feeling about the essential character of San Francisco, a special charm which makes people fanatics about living there and draws a large flow of tourists. And it is also true that the opposition came from an upper-middle-class group which could have paid its share and more of the extra municipal bills—and to whom narrow calculations of economic productivity were almost superfluous.

Is it really so bad that rational technology assessments are carried out to justify an emotionally-based position? Is this really threatening? What is technology for, anyway? Isn't its true purpose to continually threaten fixed intellectual and political and social structures, and to provide the wealth which permits free emotional choices?

A Plurality of Assessors

One of the most interesting discussions of technology assessment recently was an unnoticed speech by the physicist Richard L. Garwin of I.B.M. and Columbia University at the spring meeting of the American Physical Society in Washington. Garwin is a tight thinker who spends a lot of his time on work for the President's Science Advisory Committee; he has interested himself in such questions as the need for a lot of applied research in the delivery of medical care and the relative merits of a national commitment to the supersonic transport or to a vertical-take-off short-haul airliner.

At the American Physical Society, Garwin endorsed a bill introduced by Sen. Henry M. Jackson (the chief sponsor of the 1969 air quality legislation that set up such institutions of technology assessment as the Council on Environmental Quality and the Environmental Protection Agency). Sen. Jackson's bill would create a sort of civilian RAND corporation for the environment with an outright grant of $6 million per year for five years to support its in-house research; and it would then undertake perhaps twice that much project-oriented research annually for government agencies and private foundations. Garwin liked the idea but considered that the government should actually fund several such policy assessment institutes, with different focuses of interest, whose overlapping concerns would assure that each individual institute's unspoken assumptions would be challenged.

In one respect, Garwin's ideas sounded remarkably similar to a proposal I heard from Philip H. Abelson, the Editor of *Science,* in private conversation during the 1969 meeting in Boston of the American Association for the Advancement of Science. Abelson said that policy institutes should have a large number of visiting people coming in during academic sabbaticals, much as the CERN nuclear physics research center in Geneva does. The idea is to prevent ossification by keeping the permanent staff under the constant Grand-Central-Station pressure of new viewpoints. Even with such a plan, Garwin acknowledged that the effective life of such policy study institutes—before senility set in—would be about 10 years.

Still, Garwin said in answer to a question from the floor, "you have to start somewhere. After that 10 years, you'd be far better off than you are now. It's a gamble."

Garwin said, "Technology is a powerful tool which must be kept sharp and used with care." In a world where populations are expanding rapidly and the per capita demands for resources are expanding faster still, Garwin said, technological change is coming so fast that things man does in the short span of the next 20 years could "substantially affect" his survival. In such a world, he said, "analysis must find its place alongside pragmatism." In other words, there must be something more than the self-correcting mechanisms provided by the profit system and by empirical testing of whether a device works.

A group of competing "program policy institutes" with support from several public and private sources "would raise the level of discourse on questions not limited to technological content," Garwin said—questions like energy, a volunteer army, or the delivery of health care.

The institutes would not be producing scholarly papers but rather memoranda related directly to government policy decisions. Their work would be published quickly and would lend responsibility, coherence and focus to discussions that now are rambling, if they are held at all.

The habit of such rational consideration of government decisions, Garwin noted acidly, has not caught on much in Washington. He said it was very hard to get either Congress or the Executive Branch to publicly consider the alternatives. The S.S.T., he noted, was voted up or down in isolation from alternative technologies like a vertical take-off, short-haul airliner for mass transit. The crucial argument against the S.S.T., he said, was that it was not an economic airplane. The arguments with most weight for members of Congress, however, were environmental (noise, drastic changes to the delicate balance of the stratosphere, etc.). (In this connection, he noted the irony of the head of the Environmental Protection Agency, William Ruckelshaus, lining up like a good Nixon administration soldier to argue for the economic viability of the S.S.T. "Maybe we never could be rational about a program as controversial as the S.S.T.," Garwin said.)

The issues most in need of rational assessment, Garwin noted, are those whose resolution will be only partly technical. Among those he mentioned were: the impact of tax changes on motivation and creativity; teacher promotion policy; assignment of radio and TV channels; and changes of medicaid payments and new hospital insurance plans.

The implication seemed clear: We know now how to take at least one institutional step toward rationality in policy-making. We have a long enough list of the penalties of not taking that step.

Victor K. McElheny is Science Editor of the Boston Globe; *he writes regularly for* Technology Review.

In the Public Interest

The Courts as Catalyst

Defending the Environment
Joseph L. Sax
New York, Alfred A. Knopf, 1971,
271 pp., $6.95

Reviewed by
James J. MacKenzie
Joint Scientific Staff
Massachusetts and National Audubon Societies

Is there any hope that public and private agencies can consistently incorporate long-term environmental concerns and values into their planning processes? Probably not, argues Professor Joseph L. Sax of the University of Michigan Law School in his new book *Defending the Environment.*

The answer to this question is of more than academic interest. At stake is the issue of whether extra-governmental institutions will have to be developed and permanently maintained, to serve as adversaries against powerful special interests seemingly intent on destroying irreplaceable environmental resources because of short-sightedness or economic gain.

Professor Sax concludes that there will always be a need for court suits in which citizens can seek injunctive relief from what they consider environmentally unsound projects. He argues that in courts, agencies will have to defend their decisions in adversary proceedings before professional decision makers. The adversary process has the advantage of forcing both sides to focus clearly on issues; purely emotional arguments presumably will carry little or no weight. In courts, moreover, normal political and economic influences are absent, and citizens and corporations can in principle gain an equal footing in presenting their views.

Unfortunately, as he demonstrates with several lengthy examples, environmental conflicts are often resolved not on their intrinsic merits, but rather on technicalities. This situation may be changing, however. Some states are passing laws that both provide citizens with legal standing to sue and define rather broadly their rights to a healthy environment. Sax includes a model law (which was passed in Michigan) as an appendix to the book.

Defending the Environment is supremely appropriate for the times. There is a growing concern in the nation over the adverse environmental effects resulting from the construction of highways, power plants, dams, pipelines, etc. The striking successes of single-minded agencies such as state Departments of Public Works and the Army Corps of Engineers in pushing forward with questionable projects has led to a reconsideration of agency functions and goals at both state and federal levels. A dozen or more states have set up environmental agencies in the past year or two in an attempt to streamline and coordinate environmental management and pollution abatement. At the federal level the Council on Environmental Quality, a policy-making agency, and the Environmental Protection Agency, an enforcement agency, have been created. It is too early to know whether these changes will be adequate to deal with environmental conflicts, but Sax's analysis of a number of projects leads us to doubt that they do, in fact, get "to the heart of the matter—a fundamental realignment of power." He examines proposed highways, pumped-storage plants, pipelines, and various wilderness "developments" and carefully explores how in almost every case all mechanisms except court intervention failed to protect the affected areas. One example should suffice to demonstrate why more elaborate studies, public participation, and reorganizational schemes, while certainly desirable, may still be inadequate to protect the long-term public interest.

Why We Are Failing

Professor Sax reviews the controversy over the proposed Hudson River Expressway. As he says, "All the formal tools for rational decision making were there in abundance, yet they were as a shadow to the substance of what really mattered in that dispute."

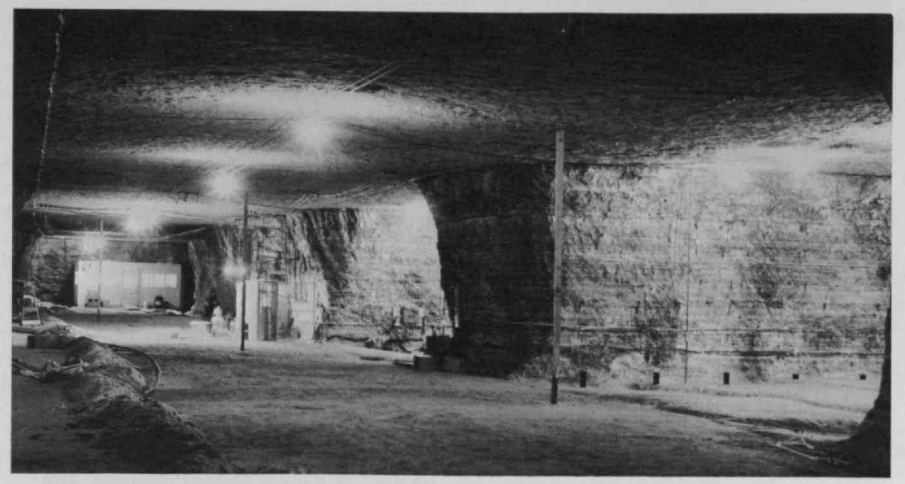
New York State, it seems, proposed in 1956 to build an expressway as part of the interstate highway system. The road at one point would have passed through the Rockefeller estate. In 1958 Nelson Rockefeller was elected Governor, after which a new route, the Hudson River route, passing far west of the estate, was developed and promoted. The state-financed Hudson River Expressway would have followed the east shore of the river and would have been built in substantial part by filling the river's shoreline as a base for the road. Those objecting to the road claimed that the aquatic life of the river would have been seriously damaged and that there were better routes along other established corridors.

According to Sax there were numerous public hearings and meetings on the proposed highway involving many state and federal agencies including the Fish and Wildlife Service, the Corps of Engineers, and the Department of Transportation.

Yet, despite public opposition, plans for the road went forward. In 1965 Secretary of Interior Stewart Udall opposed the river route. In the same year the New York legislature rushed through a bill, with no hearing or debate, explicitly authorizing the road. The Hudson River Valley Commission, charged with protecting the river, had no objections to the road. Its Chairman, who was a cousin of the Governor, and all its members had been appointed by Governor Rockefeller.

At any rate, in 1968, *before* the Department of Interior had completed its environmental impact studies, Secretary Udall reversed himself and privately announced to Interior staff members that he would not oppose the river route. Ultimately the project was stopped by a court injunction on the amazing grounds that the river-fill would have constituted a "dike" and that according to a (nearly) forgotten 1899 law congressional approval was needed.

According to Professor Sax, it "does not take much of a diagnostician to identify the disease which infected the Hudson River Expressway controversy. Its name: politics. Its carriers: Nelson Rockefeller [author of *Our Environment Can Be Saved*] and Stewart Udall [author of *Quiet Crisis*]. Its cure: *not* more studies, more commissions, or more public hearings."



The abandoned salt mines at Lyons, Kansas, (tunnels shown in photo above) have been proposed as a site for permanent storage of solidified high-level radioactive wastes from commercial nuclear power plants. Many communities don't want the nuclear power plants, much less their highly radioactive wastes which will need up to a half a million years to become nonlethal.

In his review, James MacKenzie, of the Joint Scientific Staff, Massachusetts and National Audubon Societies, comments on the use of the courts by defenders of the environment. Will Kansas turn to the courts to avoid becoming the nation's nuclear junk yard? They might, for there is a growing trend to use the courts to fight all sorts of "pollution" problems, including radiation emissions, as a question of states' rights. Dr. Norman Rasmussen, Professor of Nuclear Engineering at M.I.T., comments on "the Minnesota case" in his review. The State of Minnesota has sued for the right to regulate emissions from nuclear power plants.

Meanwhile, back at the salt mines, preparations are underway to use them as nuclear waste depositories. Nuclear waste from civilian power plants, it is estimated, will average 58,000 cu. ft. per year by 2000 A. D. It must be put somewhere, but why in a salt mine? Because, say the experts, salt fields seem to be genuinely detached from the biosphere. There is no flowing water in them; they are not prone to geological disturbance—the Kansas field formed millions of years ago and has not been geologically disturbed since; and salt seals up around anything put into it. Mines offer easy access to the necessary depth—the Lyons salt field is 300 feet thick and gives access 1,000 feet down.

It seems clear that in this instance court action was the *only* mechanism that prevented the construction of the highway.

Weighing the Intangible Costs

I agree wholeheartedly with Sax that a theory of public rights should be developed to expedite such court actions although I do not share his generally pessimistic view that planning groups cannot be made responsive to environmental concerns. What has been lacking in the past was the requirement on the part of agencies to weigh and include the undesirable (and sometimes intangible) social costs along with the direct costs when a proposal was being reviewed for its feasibility. What is needed, therefore, is a change in policy so that these costs will be included in the total analysis. Of course such policy changes do not spring out of a vacuum. They occur largely because of the resistance that court cases and the attendant adverse publicity generate in implementing traditional policy planning. In this sense litigation may well be a necessary ingredient for social change.

We are in a period of transition in thinking about the environment. And because we are in the middle of continuing controversy and debate it is difficult to see exactly where we are going and what changes will be needed to protect environmental quality—while still permitting some reasonable amount of growth.
It is generally agreed among environmentalists, however, that fighting court cases can lead to only temporary victories at best and that in the long run if *policy* changes do not occur the strategy is doomed to fail. The hope, it seems to me, is that our present tactics, including court suits, will serve primarily as a catalyst for political change and that the need for them will diminish as we develop more balanced goals and the more responsive institutions needed to achieve them. *Defending the Environment* is an important contribution to this process of change. It explains clearly the philosophy and limitations of court suits and, as a bonus, documents some of the political machinations that contribute to present environmental mismanagement.

Balancing the Equation

Nuclear Power and the Public
Harry Foreman, editor
Minneapolis, University of Minnesota Press, 1970, 273 pp., $9.00

Reviewed by
Norman C. Rasmussen
Professor of Nuclear Engineering
Massachusetts Institute of Technology

During the past two decades man has developed nuclear energy to the point where it is now a practical method for producing large amounts of electricity. Today nuclear power stands as the only practical alternative to the burning of large quantities of fossil fuels for meeting the ever increasing electric power demands of society. Although hydroelectric and geothermal power stations have been built, the total useful resources of these forms of energy are so small that even if fully exploited they could not produce more than a small fraction of the anticipated demands. Other methods, such as solar or thermonuclear power, are still in the early stages of development. Even with good luck it will be at least two decades before a practical, large power station employing these methods could be operating.

The advent of large nuclear power stations has brought with it considerable public controversy and concern. One focal point of this public concern gelled in the state of Minnesota where the Monticello nuclear plant is being built by the Northern States Power Company. *Nuclear Power and the Public* is a collection of papers given at a symposium held at the University of Minnesota for the purpose of developing a better understanding of both the risks and benefits of nuclear power. The book presents a range of opinions by technical, political, and legal authorities involved with nuclear power.

Concerns of the Public

What are the concerns of the public? As might be expected much of the concern centers on the environmental impact of these large nuclear generating stations. Of particular concern are the possibilities of a catastrophic accident, of low level radioactive pollution, and of thermal pollution. In addition to these basic concerns, one also hears considerable criticism of the federal government's role in nuclear development. These critics question the wisdom of the role of the A.E.C. as both promotor and regulator of the industry, the underwriting of nearly $500 million worth of liability insurance on each reactor by the federal government, and the position of the federal government that it has the sole right to set radioactive release standards. This last point is the subject of current litigation between the state of Minnesota and the federal government.

The papers in this book are an enunciation of these concerns and the response to them by people in the nuclear industry. Here are some of the key points.

The Major Accident Question
Modern nuclear power reactors cannot explode with the release of the large amounts of energy normally associated with a nuclear explosion. The reason is that they contain large quantities of non-fissionable material which limits the rate at which the chain reaction can grow. Tests conducted by the A.E.C. in the remote deserts of Idaho showed that the maximum energy release that could be obtained before the chain reaction shut itself off was of the order of pounds of TNT, not the thousands of tons of TNT energy yield of nuclear explosives.

What accidents are of concern? The accident that is considered most serious is the rupture of the primary cooling system. This system contains large quantities of water at high pressure and temperature. If the system ruptures, this water will flash to steam. Although the chain reaction will stop with the loss of water, the heat generated in the highly radioactive fuel is enough to melt it if it is not cooled. Reactors all contain carefully engineered safeguards to provide emergency cooling for the fuel to prevent its melting in such an emergency. Should all these systems fail and some of the fuel melt and release radioactivity, the public is further protected by the containment. This containment consists of a gas-tight barrier that completely surrounds the entire reactor and is designed to survive the pressure caused by the flashing to steam of all the water in the primary system.

There is, of course, a very small but finite chance that all these systems might fail and that radioactivity would be released into the environment. In an extreme case, this could be a very serious accident. Such an accident might be comparable in severity to the failure of a major hydroelectric dam. It is interesting to note that there exist in the world about 10,000 major dams which have been failing at the rate of about 1 per year. Although we have no statistics on the failure rate of reactors, careful safety analysis of these systems predicts a failure probability much smaller than the 10^{-4} per year for dams. Clearly this small possibility of a major failure is one of the risks of nuclear reactors that must be weighed against their benefits.

The nuclear plant releases a very small amount of radioactivity but interestingly enough the coal station also emits a small amount of radioactivity because of the small amount of natural radioactivity in coal. In both plants, the radiation level is small compared to the natural background level.

Pollution from Normal Operation
All reactors release small quantities of radioactivity during normal operation. In addition, the spent fuel contains radioactive products of fissions which must be removed and stored in some careful way for hundreds of years. It is incumbent upon the nuclear industry to have solutions to the problems of controlling emissions and radioactive wastes if reactors are to be accepted as a method for electrical generation.

Reactor manufacturers have recently developed methods for greatly reducing the radioactive release from plants. It is anticipated that plants employing these systems will release so little radioactivity that it won't be measurable at the site boundary. This means that the radiation level due to the reactor will be several orders of magnitude smaller than the radiation level due to the natural radioactivity in the things around us.

The present solution to the problem of radioactive wastes is to solidify them in a ceramic insoluble form and then store them in an abandoned salt mine. Salt mines are chosen because the existence of such deposits indicates that there is no significant movement of ground waters in the deposit and because the salt will chemically bind up any small amounts of radioactivity that might escape. The total amount of highly radioactive waste from a 1,000 MW. reactor would be a few tons per year so that the total volume of storage space required for many years is readily available in abandoned salt mines.

Thermal Pollution
The thermal efficiency of a modern nuclear plant is about 32 per cent. This means that a 1,000 MW. nuclear plant rejects heat at a rate of 2,000 MW. The condensers of such a plant require a cooling water flow of about 1,500 cubic feet per second, about 1 per cent of the average flow of the Columbia River. The temperature of this condenser cooling water will be increased about 15° F. In many of our smaller rivers this heat output might increase the entire river temperature by 5° to 8° F., during low flow periods in the summer. Since such a temperature rise would be intolerable in many rivers, more and more of the inland plants are resorting to cooling towers or cooling ponds to avoid undue heating of natural bodies of water. The problem is much less severe at ocean-side sites but care must be taken not to overheat estuaries or tidal marshes.

Nuclear versus Fossil Fuel
Any evaluation of the desirability of nuclear power can be kept in perspective only through a comparison with the alternative power generation methods. As mentioned above, the only alternative in almost all sections of this country is fossil fuel (oil or coal). Let us compare the environmental impact of nuclear and fossil fuel plants of 1,000 MW size. A 1,000 MW. coal station will burn about 10,000 tons of coal a day or about 3,000,000 tons a year. The plant will release about 30,000 tons of air pollutants a day, mostly CO_2, SO_2 and NO_x plus some particulate matter. The plant will also produce about 300,000 tons of ash per year. The nuclear plant releases no chemical or particulate air pollutants, burns about 30 to 50 tons of uranium fuel per year and produces a few tons of highly radioactive waste. The nuclear plant releases a very small amount of radioactivity but interestingly enough the coal station also emits a small amount of radioactivity because of the small amount of natural radioactivity in coal. In both plants, the radiation level is small compared to the natural background level.

A fossil fuel plant generally has a thermal efficiency of nearly 40 per cent and the amount of heat rejected to condenser cooling water may be only 50 to 60 per cent of that from a nuclear plant of the same size. Thus, although a fossil plant will have a thermal pollution problem, it will be less severe than for a nuclear plant.

The worst accident for a fossil fuel plant is probably a fire in the fuel storage area. In the case of an oil fired station, this could be a major fire that would endanger the lives and property of the public. The worst conceivable accident at a nuclear plant would result in the release of a large amount of radioactivity to the environment and would certainly be a much more severe accident than a large oil fire in terms of potential damage to the public.

Which type of plant should be built in a given locality will in the end usually de-

pend upon the problems at that locality. In areas where fossil fuel is expensive or where air pollution is already a severe problem nuclear energy would seem to have an advantage. In areas where fossil fuel is cheap or where air pollution is not so serious, fossil fuel may be the energy source of choice. It would seem that for many years to come both sources of energy will be exploited to meet our electric power needs.

In the final analysis, however, there will have to be public acceptance of whatever form is to be used. I feel that this public acceptance can only be obtained by a frank and open exchange of information between the utilities and the public.

State versus Federal Control

Under the present Atomic Energy Act, the Congress has given the A.E.C. the right to set radioactive release limits for reactors. The State of Minnesota claims that it should have the right to set limits lower than the federal limits if it so desires. Recently a federal judge in Minnesota ruled that the statute does give the A.E.C. the sole right to set these limits. Minnesota has appealed this ruling.

The proponents of nuclear power argue that the Congress was wise to set up the responsibility in this manner, for the A.E.C. is the only governmental agency with a group of people highly trained in all aspects of nuclear reactor safety and hence the only group capable of making such a highly technical judgment. The opponents have argued that they feel any state should have the right to set limits lower than the federal limits for their own state. Further, since the reactor operators have claimed that under normal conditions they will operate at about 1 per cent of the federal limits, why not make it a requirement that they do so? Both arguments have some merit. It would appear, however, that if the states wish to retrieve this right it will have to be done by a vote of our elected representatives in Congress.

A book of the type reviewed here may not be as coherent as one would like because it is written by 13 different authors, but it does serve the purpose of presenting both sides of the issue. This feature has been lacking in practically every recent book on nuclear power. I would like to applaud the University of Minnesota for sponsoring the symposium and Dr. Foreman for getting out the proceedings of the symposium in book form. I believe that a book of this type represents one important way of disseminating information to the public. I would recommend that all citizens concerned about the development of nuclear power read it.

The Same Old Marvels

Everyday Science
Daniel Hershey
Doubleday, 1971, 168 pp., $5.95

Reviewed by
Fred Wheeler

Perhaps the first thing to be clear about is that this book is not to be confused with the same publisher's excellent Science Series (which is British in origin, and is mainly about technology). *Everyday Science* is dreadful, in ways which I shall mention briefly as a prelude to the main point of this review.

The author's central claim is in the book's subtitle: *Introducing the Scientific Explanations Behind Some Ordinary Phenomena.* In words we have often seen before, the layman is given to understand that he will be enabled to comprehend "some of the basic scientific principles involved in our everyday life," and thus will regain a sense of "the beauty and wonder of nature." All he needs is an ability "to 'reason' things through."

He will also need to have undergone a rather odd kind of schooling, which left him familiar with the trigonometrical ratios but unfamiliar with the lever. And he had better dispense with the inconvenience of reason altogether, for Hershey is a dispenser of gospel truths rather than explanations.

The number of times Hershey steers the reader into the general area of a simple explanation and then neglects to supply any explanation at all is truly astonishing. And such explanations as he does give are surprisingly often presented so as to closely resemble popular fallacies. If the reader thought that jet-engines work by heaving against the air behind, or that the earth's gravitational field rapidly dwindles away outside the atmosphere, he will think so still. *Everyday Science* comes close to doing for science what *1066 And All That* did for history, with the difference that it didn't make me laugh.

Even if one gives the best available explanations for things, one does not thereby teach very much science, for what drives science—pure and applied—is not the answers but the questions. At only one point does Hershey mention a current unknown. One would be led to believe that all the science of any interest has already been done. If this is what the layman is being taught, we can hardly expect him to be a very enthusiastic supporter of his National Science Foundation.

This brings us to the final twist. All of the science in *Everyday Science* is nineteenth century or earlier. Hershey's layman lives in a world in which science—the search for explanations of that world—came to a halt before he was born. Of course, he has seen technology change his life—but as if by magic.

Such science as has been done in his lifetime is clearly none of his business. He didn't ask for it, and he doesn't get it. Hershey's layman does not inhabit a scientific information-explosion. In his world, it's all over, long ago.

The joke, if there is one, is that this is not the case. Last year, a British scientist became a kind of public clown/hero with a piece of research on why a bicycle does not fall over (and I assure you, my postdoctoral reader, that if you did not read his paper—or the popular London newspapers—you almost certainly still have one of the wrong ideas about bicycles). Cloud physicists are still not entirely sure that they know where lightning comes from. Acoustics, 60 years after Sabine, is still not able to predict satisfactorily the performance of a concert hall. And has anyone not wondered how migratory creatures find their way? And has anybody really found out?

We are still awaiting the layman's book on everyday science. It would consist almost entirely of unanswered questions, and would thus evoke a certain sense of wonder. It might conclude with a, for once reasonable, plea for funds.

(an informative advertisement)

We're one of the causes of air pollution.

(We're also one of the prime solutions.)

A sunny day in New York City. Automobiles are to blame for that—or are they?

We listen. We know people are upset about air pollution, and they have every right to be. If you're one of those people, you'll be interested in this ad. It isn't a pious cop-out, and it doesn't sugarcoat the issue. What it does offer is a frank discussion of what Ford Motor Company is doing to solve its share of the problem.

First of all, Ford Motor Company is concerned about air pollution.

Because we're in business to make money.

And we make money by listening to what you want.

And we know there isn't much future in offering you a product that is going to make an already serious problem worse.

But on with the facts.

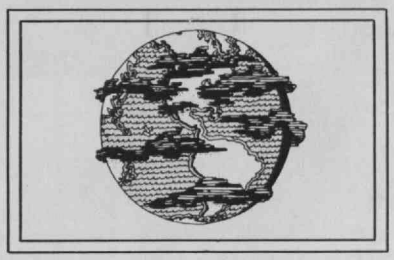
"I REGARD THIS (POLLUTION) AS THE MOST IMPORTANT PROBLEM FACING THIS COMPANY..."
HENRY FORD II

Fact number one is a sad one.

That if automobile air pollution were ended tomorrow, there would still be a serious problem. Not just in this country, but in cities the world over. And that is because automobiles are not the only cause of air pollution.

Visible air pollution in New York City, as well as most other cities, comes primarily from industrial smokestacks, jet aircraft, incinerators and many other sources—not just automobiles.

It is true, however, that in certain areas such as the Los Angeles Basin,



Cars are part of the problem; but not the *whole* problem.

cars are the major source of air pollution. Nationally, on a weight basis, automobiles represent 39 per cent of the total pollution output. But a recent study by two California professors indicates that cars are responsible for only 12 per cent of U.S. air pollution, based on "harmfulness."

But that is not to duck the issue.

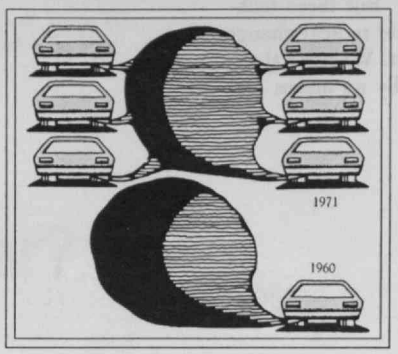
"THIS CONCERN WILL BE REFLECTED... IN SPECIFIC, CONCRETE ACTIONS..."
HENRY FORD II

Automobiles do give off hydrocarbons, carbon monoxide and nitrogen oxide, the last two of which can be toxic. Furthermore, hydrocarbons and nitrogen oxide are the main elements in what is known as "photochemical smog."

Ford Motor Company began tackling the hydrocarbon part of the problem years ago. In 1961, we brought out our first anti-pollution device. It wasn't a magic cure-all, and it certainly didn't solve the entire problem. But it was a start.

Today, our cars have a clean-air system that reduces carbon monoxide emissions by 70 per cent, hydrocarbons by 80 per cent.

In fact, it takes five to six of our 1971 products to equal the carbon monoxide and hydrocarbon emissions of a single 1960 automobile.

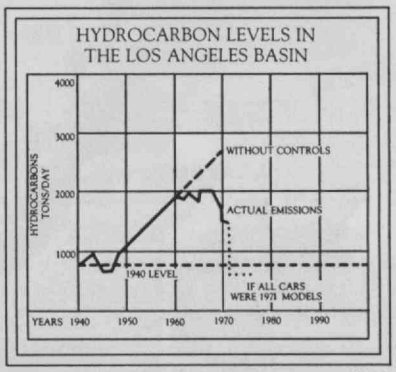


Today's car isn't the polluter its ancestor was.

The nagging problem, however, is getting rid of the nitrogen oxides. It's going to require control— not just of car exhausts—but of many sources of combustion as well. By 1973, Ford engineers plan to have our share of the problem cut in half. And by 1976, even greater reduction will be required.

Progress is being made.

In Los Angeles, for example, the town with the worst smog problem in the country, hydrocarbon and carbon monoxide levels are down 20 per cent since 1966. And, as the chart shows,



The battle against pollution is being won because we didn't start fighting it yesterday.

if all cars were as "clean" as our 1971 models, hydrocarbon levels would be well below what they were in 1940.

Nevertheless, there's a lot more to be done. And because there is, we're committed to a continued detailed program of specific activities to reduce pollution from our plants and products (see below).

WE WOULD LIKE TO HEAR FROM YOU

Indeed, Ford Motor Company is not a lot of things—and perfect is one of them.

But another thing we're not, is insensitive.

We want your business. And we think we know what we're going to have to do to keep it.

So much for our point of view. We'd like to hear yours.

Send us your likes, dislikes, wants, needs, gripes, etc. We guarantee your letter will be read, considered, and answered.

WRITE:
FORD MOTOR COMPANY LISTENS
DEPARTMENT TR
THE AMERICAN ROAD
DEARBORN, MICHIGAN 48121

Do write us. We listen. And we listen better.

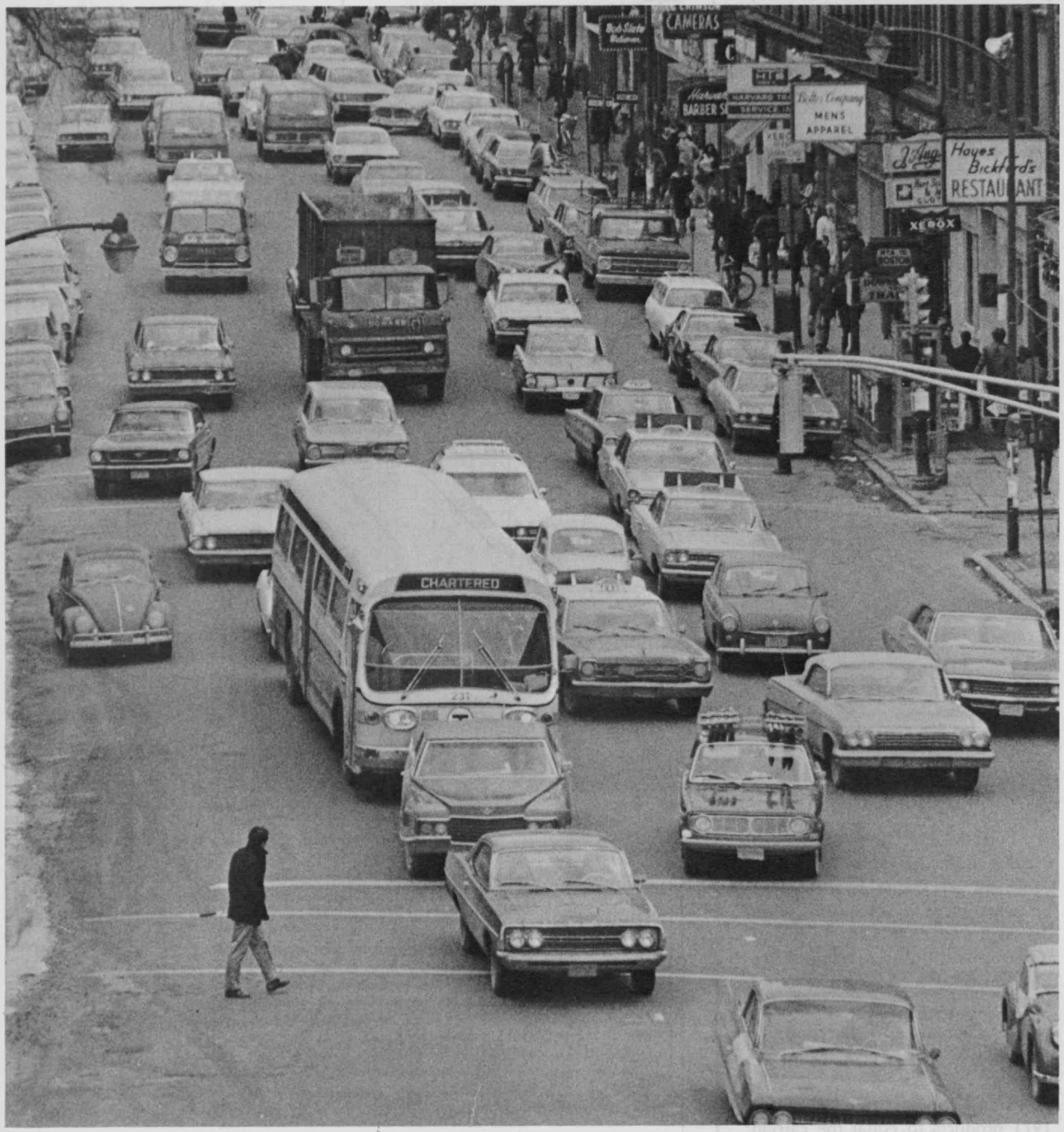
Ford

...has a better idea (we listen better)

FORD MOTOR COMPANY'S COMMITMENT TO FIGHT POLLUTION:

1. Accelerate programs to eliminate air pollution from our manufacturing plants.
2. Continue development of water recycling systems for manufacturing plants which will eliminate water pollution.
3. Continue to develop techniques for disposing of plant waste without pollution.
4. Continue to develop engines which will further reduce carbon monoxide and hydrocarbon emissions below the 70% to 80% reduction achieved to date.
5. Make multi-million dollar investment to strengthen quality control procedures for measuring anti-pollution devices on all Ford Motor Company products to meet required low-emission levels.
6. Explore new fuel compositions in accordance with latest developments in engine and pollution control technology.
7. Develop new tools to aid emission inspection at automotive repair centers and assist Ford Motor Company dealers in improving emission inspection procedures.
8. Make multi-million dollar investment in permanent laboratories and test facilities designed to better understand combustion processes.
9. Continue to investigate alternate power sources such as steam, turbine, electric, etc., although we believe the internal combustion engine still is the most practical power source.
10. Accelerate procedures for worldwide dissemination of pollution control information within all Ford engineering facilities.

The progress made between 1968- and 1971-model automobiles demonstrates that carbon monoxide and hydrocarbon emissions can be "substantially reduced," says the author. But these techniques can hardly be extended further, and more radical changes will be required if 1975 standards are to be met. Whether that can be achieved for production automobiles is by no means certain.



By 1975 making an automobile will be more difficult and operating it will be more costly. But federal legislation (which effectively assures that it will be powered by an internal combustion engine) holds promise that our air will be cleaner

John B. Heywood
Associate Professor of Mechanical Engineering, M.I.T.

How Clean a Car?

The tortuous path of automotive pollution control reaches a climax in 1975. For the first time in history, Congress has written into law specific emission standards—a 90 per cent reduction in emissions from the 1971-model-year cars, which already have some degree of emission control—and they are to be effective with cars produced in that year. Environmentalists view these developments as a legislative triumph, while the automobile industry interprets them as a disaster which makes an already difficult task almost impossible.

To resolve these views, we must answer two vital questions: Just how clean a car do we really need, and how will we know when we have it? And can a car be made that clean in the time available?

The Nature of the Problem

The story of automotive pollution control begins in Los Angeles in the early 1940's, when there first became evident a white smog which reduced visibility and caused eye irritation. A local program to reduce dust and fume emissions from stationary sources did not alleviate the smog proportionately.

Within a decade Professor A. J. Haagen-Smit demonstrated with laboratory experiments at the California Institute of Technology that the smog resulted from the release of large quantities of hydrocarbons (HC) and nitrogen oxides (NO_x). Before these gases were fully dispersed they underwent a photochemical reaction—one where the energy to initiate the reaction comes from sunlight—and formed oxidants in small but nonetheless hazardous amounts. Estimates showed that in the Los Angeles basin the dominant source of hydrocarbons and nitrogen oxides was the automobile. It still is today.

These oxidants, which are ozone and reactive organic oxidizing compounds, have several adverse effects. First, they can directly affect the lungs and eyes of people, causing respiratory and eye irritation and possible changes in lung function. They are extremely toxic to many plants. They can physically weaken such materials as rubber and fabrics. (In fact, car tires in California contain additives to protect them against ozone attack.) And the aerosols formed in these atmospheric reactions contribute significantly to the white haze which cuts down visibility.

Though Los Angeles is still the U.S. city with the worst photochemical smog problem, due to its high traffic density, stable atmosphere, and sunny climate, field data show that the oxidant concentration at which eye irritation occurs (about 0.1 p.p.m.) is exceeded in most major California cities and in St. Louis, Denver, Philadelphia, Cincinnati, Chicago, and Washington, D.C., on about half the days of each year.

Smog is not the only air pollution problem attributable to the automobile. Evidence suggests that the nitrogen oxides, which play such an important role in the photochemistry of smog formation, are in themselves a health hazard. The internal combustion engine is also the only significant source of carbon monoxide and lead in our urban atmosphere.

Carbon monoxide (CO) is invisible, odorless, and tasteless; inhaled into the lungs, it passes directly into the blood stream. There, because blood has a greater affinity for absorbing CO than oxygen, the oxygen-carrying capacity of the blood stream is reduced. High CO concentrations place greater strain on persons with heart disease. Exposure for several hours to CO levels of 10 to 15 p.p.m. sufficiently reduces the oxygen supply to the brain so as to affect brain function, altering, for example, time-interval discrimination. Average CO concentrations in vehicles in several major urban areas are already about 30 p.p.m., and there is thus obvious concern that high CO levels could be a contributing factor to traffic accidents. The worst city appears to be Chicago, with a highest recorded eight-hour average of 44 p.p.m.!

Whether lead emissions from automobiles are a health hazard is still a matter of controversy, but their control is promised by the gradual adoption of unleaded gasoline likely during the next five years.

Where Do the Emissions Come From?

The 100 million motor vehicles on the road today are the source of about 60 million tons of CO, 16 million tons of HC, and 7 million tons of NO_x annually—1,200 pounds CO, 320 pounds HC, and 140 pounds NO_x per car. In an uncontrolled vehicle—that is, a car sold before any pollution-control devices were required—these emissions come from the engine crankcase, from fuel evaporation in the fuel tank and carburetor, and from the exhaust pipe.

To measure its exhaust emissions, a vehicle is driven through a prescribed speed-time pattern on a dynamometer. A fraction of the exhaust is collected in a bag, and at the end of the test pollutant concentrations in the bag are measured with special electronic gas-analyzing equipment to give the emissions in grams per mile of travel.

Automobiles built in 1975 and thereafter must be capable of markedly lower emissions than any built heretofore in the U.S. The table below compares emissions from an uncontrolled vehicle and federal emissions standards. The author suggests that current technology can produce the required results on new 1975/1976-model cars; but deterioration—from inadequate maintenance and durability—seems inevitable as these vehicles age.

Inside the internal combustion engine cylinder, the pressure difference across the piston rings forces unburned fuel-air mixture into the crankcase; vented to the atmosphere, this crankcase blow-by was responsible for 20 per cent of total HC emissions. In model years since 1963, these gases have been returned to the intake manifold through a positive crankcase ventilation (PCV) system and burnt in the engine.

Fuel evaporating from gasoline tank and carburetor through overflow and venting channels accounted for a further 20 per cent of the total HC emissions from pre-control automobiles. Starting with 1971 model-year cars, these losses are about 90 per cent controlled by inserting a carbon-filled canister to absorb the gasoline vapor, which is subsequently recycled to the engine.

Engine exhaust gases contain all the CO and NO_x emissions and the remainder of the HC. These pollutants are formed through different processes inside the engine. The hydrocarbon emissions—a mixture of unburnt gasoline vapor and organic compounds—are formed when some of the fuel is heated but not burned inside the engine cylinder. When each spark plug is discharged, flame propagates outward through the cylinder from the point of ignition; but the fuel-air mixture close to the cylinder wall remains too cool to ignite. Thus some hydrocarbon-rich layers along the cylinder wall remain in the cylinder to flow into the exhaust pipe during the exhaust stroke. Engine misfire, where a substantial part of the bulk fuel-air mixture in the cylinder is unburnt, will drastically increase HC emissions.

Carbon monoxide also results from incomplete combustion, but in a different way. If there is not enough air in the fuel-air mixture to fully burn the fuel—or insufficient time in the cycle for combustion to be complete—all the carbon in the gasoline cannot be burned to carbon dioxide (CO_2); some must stop part way as CO. Fuel-rich conditions yielding CO in the exhaust are necessary for steady engine operation at idle and for maximum power during acceleration; and even if enough air is present, the rapid cooling of gases as the piston moves down during the power stroke sufficiently slows the combustion process to "freeze" a small amount of CO in the exhaust gases.

	Carbon monoxide		Hydrocarbons		Oxides of nitrogen		Particulates	
	g./mi.	Per cent reduction from uncontrolled vehicle	g./mi.	Per cent reduction from uncontrolled vehicle	g./mi.	Per cent reduction from uncontrolled vehicle	g./mi.	Per cent reduction from uncontrolled vehicle
Uncontrolled vehicles	125	—	16.8	—	6	—	0.3	—
Present degree of control	47	62	4.6	73	—	—	—	—
1972 standards	39	69	3.4	80	—	—	—	—
1973 standards	—	—	—	—	3	50	—	—
1975 standards	4.7	96	0.45	97	—	—	0.1	67
1976 standards	—	—	—	—	0.4	93	—	—

Nitrogen oxides are formed whether combustion is complete or not. At the high temperatures which occur in an internal combustion engine during the burning process, oxygen and nitrogen combine to form nitric oxide (NO). The higher the peak temperatures and the more oxygen available, the more NO is formed. There is then insufficient time for this gas to decompose as the burned gases cool during the expansion and exhaust processes. Though both NO and nitrogen dioxide (NO_2) are significant air pollutants (together termed NO_x), the NO_2 is formed in the atmosphere as NO is oxidized.

Engine-operating conditions such as fuel-air ratio and spark timing affect these three formation processes in different ways. At idling speeds, CO and HC concentrations in the exhaust are high because the mixture is fuel-rich for smooth running; but NO_x concentrations are low because with a rich mixture there is less oxygen available and peak gas temperatures are reduced. When the vehicle cruises at high speed, HC and CO concentrations are low because the mixture is slightly fuel-lean for best economy and thus air is available to fully burn the fuel. But NO_x concentrations are higher because peak gas temperatures have increased, and more oxygen is available to react with the nitrogen. To control all these emissions over the complete range of engine-operating conditions is not an easy task.

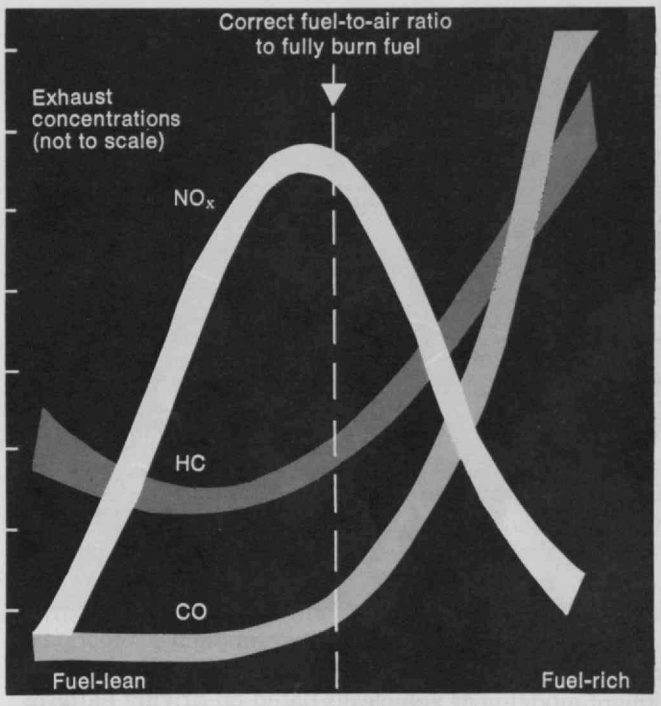
A further complication in assessing these emissions is the varying air and exhaust flow through the engine as engine speed and throttle setting are changed. Thus concentrations of pollutants in the exhaust at idle do not contribute to total emissions in proportion to concentrations during rapid acceleration, because the exhaust flows from the engine are so different.

The Federal Control Program

The federal government's vehicle emission control program, which first imposed nationwide emission standards on 1968 model-year cars, is based on the following premises. First, that ambient concentrations of CO, HC, NO_x, and oxidants in our major urban areas are much too high and must be substantially reduced; both health and environmental damage have been demonstrated beyond reasonable doubt. Second, that since there are only a few major manufacturers of automobiles, control is best carried out at the source—on new vehicles. Third, that since automobiles are sold nationwide, control should be at the federal and not the state level. (Though initially California's control program has been allowed to proceed at a faster rate, by 1973 the degree of control required throughout the nation will be about the same.)

Today there would be little disagreement between the automobile industry and the federal government on these objectives. It is in the next stage—the precise details of the emission control program—that the controversy arises. Ideally, a logical chain should be worked out. First, ambient air quality goals should be selected which adequately protect health and the environment. Second, emissions from automobiles should be linked to those ambient concentrations.

Emissions from a given automobile engine vary with the fuel-air ratio in the combustible mixture. Fuel-lean mixtures (excess air) give low hydrocarbon and carbon monoxide emissions but high nitrogen oxide pollution. With fuel-rich mixtures the relative proportions are reversed. No single operating point reduces all three pollutants.

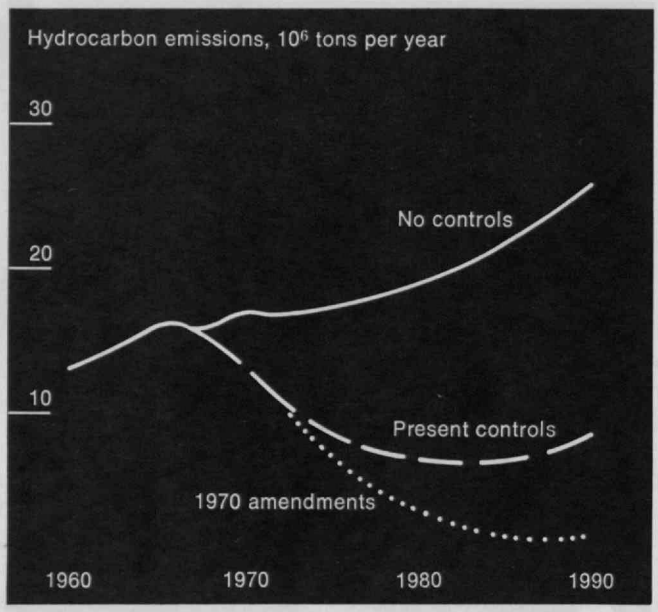


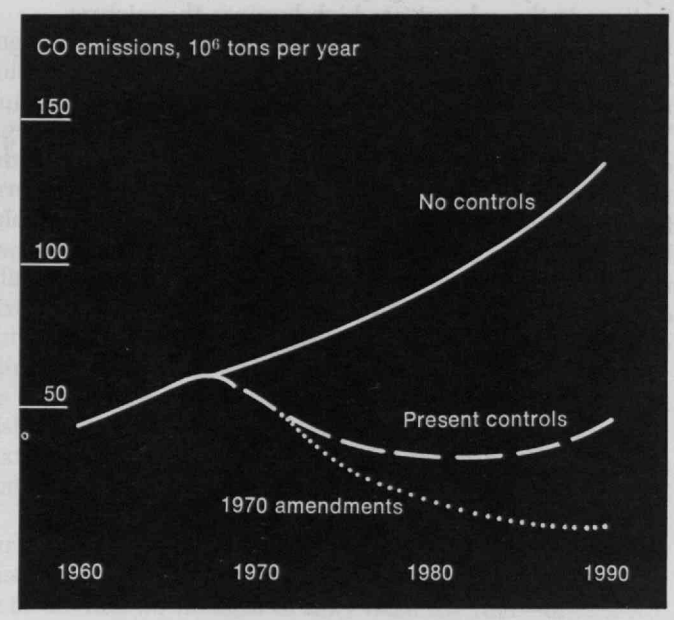
Third, the rate at which emissions must be reduced to attain these goals should be established. But in practice none of these steps is that easy.

There is still controversy over desirable air quality goals. Indeed, as George D. Robinson pointed out in this magazine last month, measurements of air quality on which to base standards are far from simple to make.

The next problem is to determine exactly the emissions of any particular vehicle in relation to a standard. Any typical drive is a continuous sequence of different vehicle-operating modes—engine start-up followed by acceleration, cruise, deceleration, idle, acceleration, and so forth. As explained above, the concentrations of each pollutant in the exhaust gases, and the exhaust flow rate, vary with vehicle operation. The aim is to reduce the total mass of pollutants emitted per mile driven, so a measuring technique which covers all operating modes must be developed. The solution has been to use a test procedure which simulates a series of typical urban driving patterns, the vehicle being driven through a prescribed speed-time sequence with its rear wheels on a dynamometer. The driving cycle which will be used by the Air Pollu-

Using projected vehicle population figures, nationwide emissions of HC, CO, and NO_x from gasoline-powered motor vehicles can be estimated. Present controls are predicted to reduce total emissions until 1980; then emissions rise due to the ever-increasing number of cars on the road. Emission standards in the Clean Air Act Amendments of 1970 should continue this reduction into the 1980's if it all works as planned.





tion Control Office in the Environmental Protection Agency for testing and certifying 1972 and subsequent model-year vehicles is based on driving patterns in Los Angeles; it lasts 23 minutes and represents 7.5 miles. This "typical" drive has 18 vehicle stops and a maximum speed of 56 m.p.h., and most of the driving is between 25 and 35 m.p.h. A fraction of the total exhaust gases is collected in a plastic bag, and the bag contents are analyzed at the end of the test. The average CO, HC, and NO_x emissions in grams per mile of travel are thus obtained.

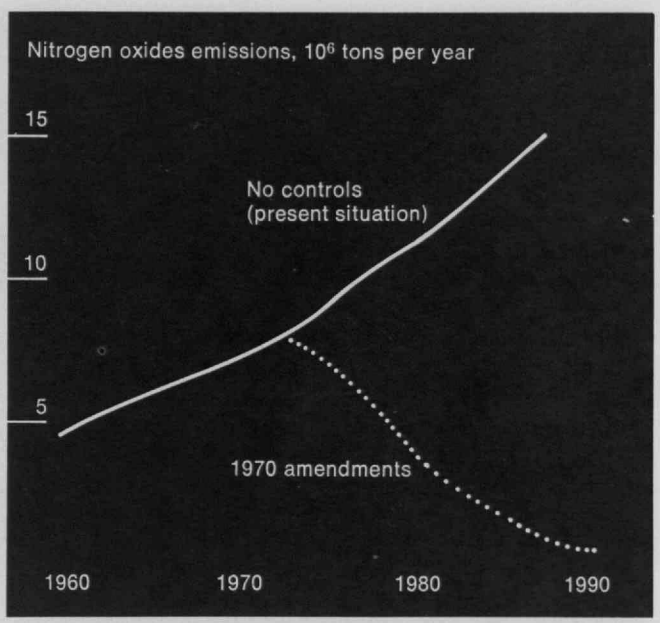
That driving pattern happens to be close to my own drive to work every morning. However, on average, will driving patterns in Boston or other major cities be similar to those in Los Angeles? The question is important because changes in driving patterns change the amounts of each pollutant emitted. We have noted that the lower speed driving results in higher CO and HC emissions. The question is how much speeds really vary between Los Angeles and—say—Manhattan, and how much will emissions vary from the prescribed standard?

Another problem is engine start-up. When the choke is used to enrich the fuel-air mixture when the engine is cold and fuel vaporization poor, HC and CO emissions increase substantially. In the new federal test the "cold start" occurs after the car has stood for 12 hours at about 70°F.—roughly overnight conditions in southern California but not in Boston in the winter. The ambient temperature affects how long the choke enriches the mixture while the engine warms up; even in the standard test the emissions during start-up are a significant part of the total.

The Problems of Test and Control

Should we wait until these questions are resolved? The answer must be no, because the control strategy chosen —progressively cleaning up new cars—takes many years to improve air quality significantly. This is true for two reasons. The total car population is a mix of a large number of model-years, and there is a considerable lag time before newer, cleaner cars will replace a substantial fraction of the older, dirtier cars on the road. Indeed, there are more old cars than one might expect; the average age of vehicles in California is six to seven years, and about 15 per cent of the cars are ten or more years old. The average age in Boston will probably be lower, since salt corrosion takes an added toll on vehicle life.

Secondly, an emission-control technology cannot be developed, tested, and then put onto 10 million vehicles a year overnight. Emission standards for new cars must be tailored to the most rapid development of



control technology that is practicable—an easy statement to make but not an easy program to define. Ideally, reductions in emissions should be related to ambient pollutant concentrations through mathematical models of the dispersion processes and the chemistry occurring in the air above our cities. We are certainly not in a position to do this now or in the near future, so a simpler "roll-back" approach is used.

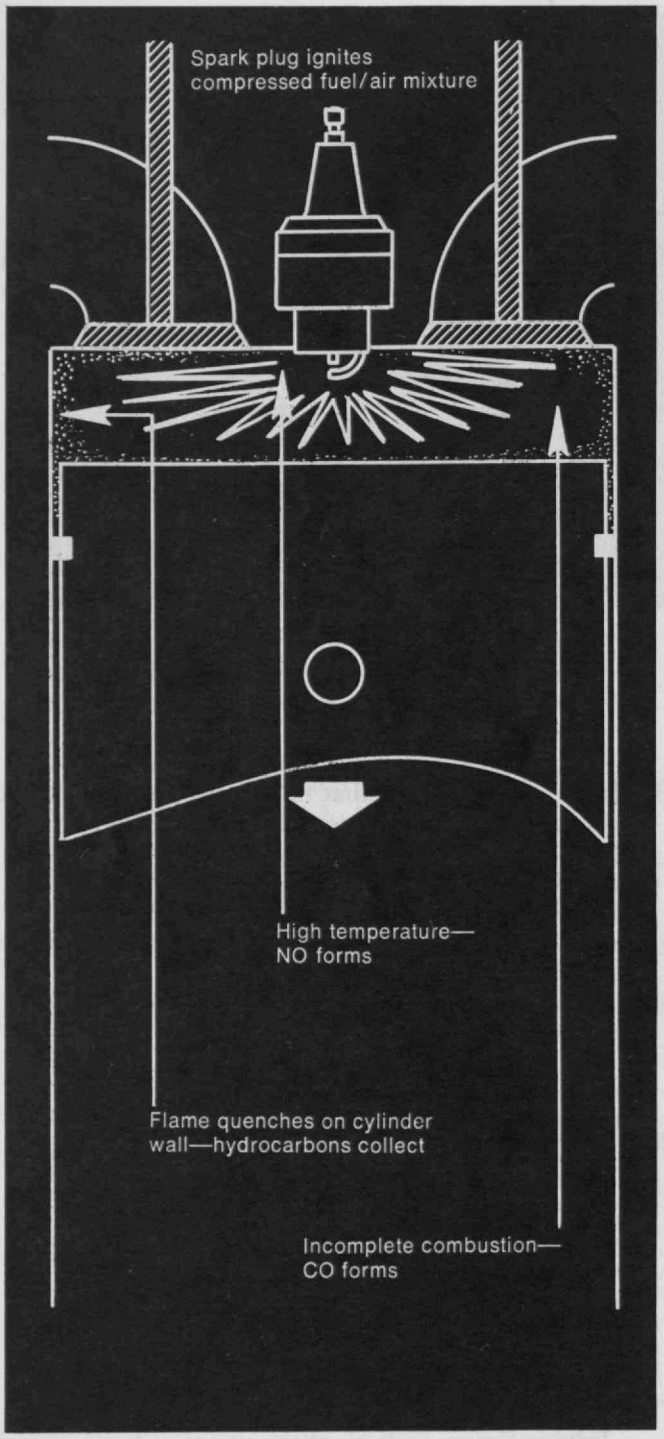
For CO, which is quite inert in the atmosphere, this technique is straightforward and works as follows: Since in urban areas automobiles are the source of about 90 per cent of all CO, the ambient concentration in any given area will be proportional to the weight emitted by motor vehicles. Thus total emissions from all vehicles must go down by the ratio of desired air quality standard to present air quality. Allowing for the increase each year in the total number of vehicles on the road and for the fact that emissions from old cars will not change, the percentage reduction in emissions required on new vehicles can be estimated.

Because HC and NO_x react to form oxidants, the rationale for their reduction is more complicated; indeed, the major aim is control of these photochemical oxidants. To accomplish this, is it better to control both emitted pollutants equally, or one more than the other? Since the atmospheric chemistry is nonlinear and not fully understood, field data are used to relate maximum concentrations of the emitted pollutants (HC and NO_x) which occur during the morning rush hour to maximum oxidant concentrations which occur a few hours later. A modified roll-back technique can then be used to calculate emission goals.

Using these techniques the National Air Pollution Control Administration estimated the required emission standards for 1980 and later model-year cars to achieve "clean air" in the mid-1980's. For CO, these federal emission goals were 4.7 g./mi., a 96 per cent reduction from emissions by uncontrolled (pre-1968) vehicles; for HC, the goal was 0.25 g./mi., a 98.5 per cent reduction; and for NO_x, 0.4 g./mi., a 93 per cent reduction. Some control of CO (62 per cent) and HC (73 per cent) has already been achieved, and intermediate standards for 1972 and 1975 were planned.

Other factors have arisen, however, to confuse this orderly sequence of events. Only standards for CO and HC had been set initially, and the various control techniques used to meet these standards turned out to increase NO_x emissions by between 15 and 50 per cent. There continues to be considerable uncertainty about the deterioration of exhaust emission controls on existing cars. It is clear that the effectiveness of present and proposed control devices does decrease with mileage. For example, latest reports show that for average cars on the road federal standards for CO are exceeded by about 13 per cent and HC standards by about 25 per cent. There are also variations in emission rates among engines of the same type due to slight differences in manufacturing. Thus though a vehicle design may meet the standard in the mean, many individual vehicles will have emissions higher than the standard. It is not easy to assess the significance of these effects because surveillance tests on vehicles on the road are frequently not directly comparable to the initial certification test.

These factors have combined to give the impression that the control program is not quite what it ought to be—an impression reinforced in the popular mind by the fact that, though emission control was introduced nationwide in 1968, the air looks just as dirty in 1971, three years later. (No observable improvement could be expected, of course, since the strategy adopted—controlling new vehicles—takes at least a decade to



have significant effects.) And in turn these are among the considerations which prompted Senator Edmund S. Muskie's Air and Water Pollution Subcommittee to propose advancing the 1980 federal goals to 1975. That proposal survived the Senate-House negotiations and votes almost intact in 1970, and it is now part of the Clean Air Act. Emissions from new cars in 1975 must be less than 10 per cent of the emissions from the new car you can buy today. We are demanding an essentially emission-free car. Can such a car be built on the four-year schedule required?

Toward a Pollution-Free Car

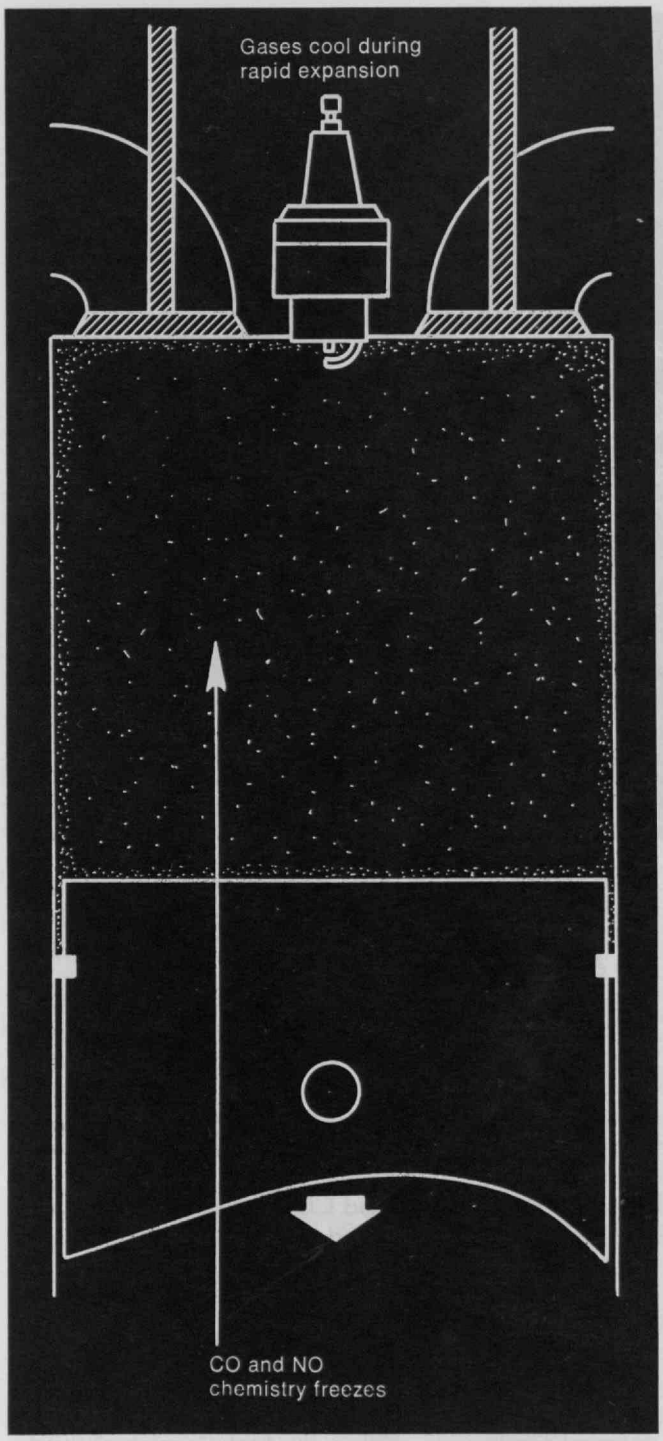
The progress made between the 1968 and 1971 models demonstrates that CO and HC emissions can be substantially reduced. These reductions, required by federal emission standards, have resulted from a combination of many different engine modifications. Crankcase blow-by containment and evaporative emission control have already been mentioned. Emissions have also been reduced through better control of fuel and air flows into the engine, adjustments to spark timing and idling speed, and technical engine design changes affecting the shape of the combustion chamber, gasketing, piston ring configuration, and compression ratio. A few engine models still require a pump to supply air to the exhaust manifold to burn CO and HC in the exhaust.

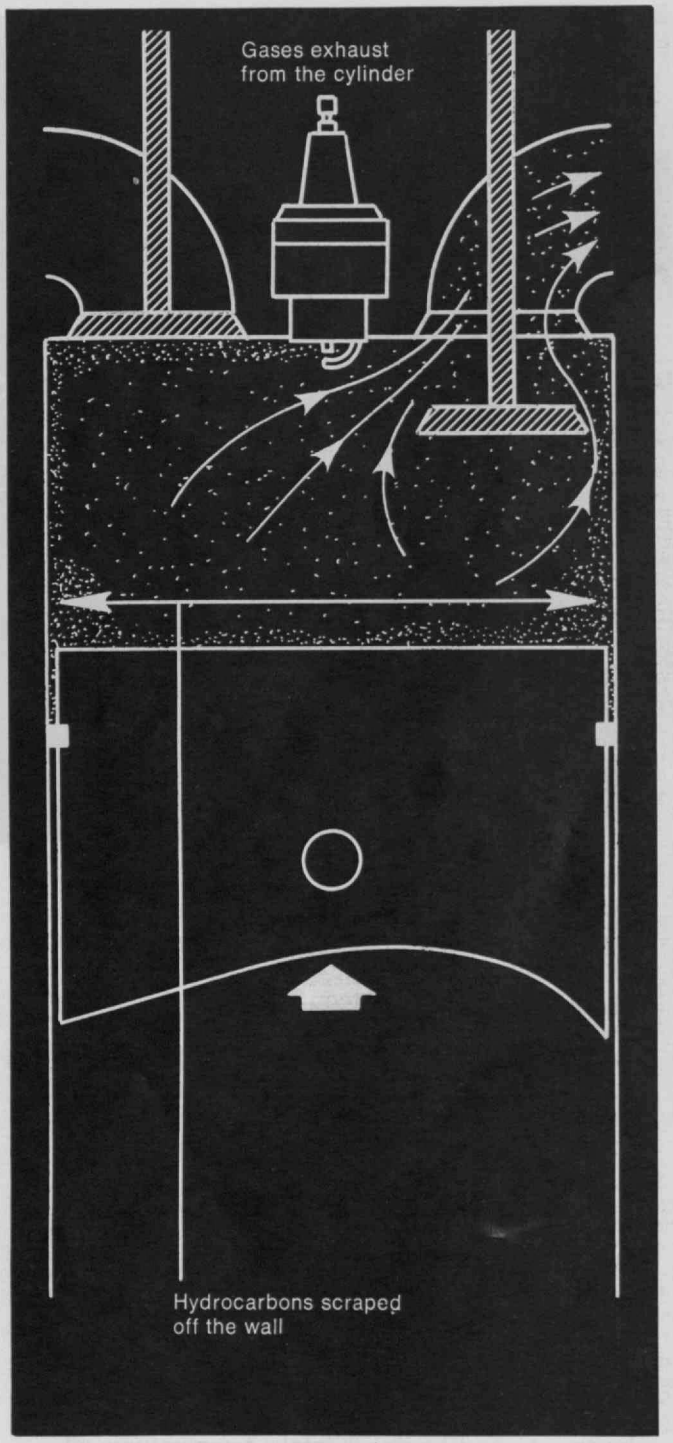
However, there is a limit to further reducing CO and HC emissions with these techniques, and only in California are any NO_x controls in service. More radical changes must now be devised.

It is ironic that by advancing the requirement of a "clean" car from 1980—the original federal goal—to 1975, Congress has effectively required that the power plant will be a spark-ignition engine. No alternative power plants—gas turbine, Rankine-cycle engine, or hybrid—could be developed, field tested, and produced in a four-year period on the massive scale required. Yet one of the original incentives to develop these alternatives was the belief that the 1980 goals might be beyond the reach of a conventional engine. So what are the prospects of developing a "clean car" in time?

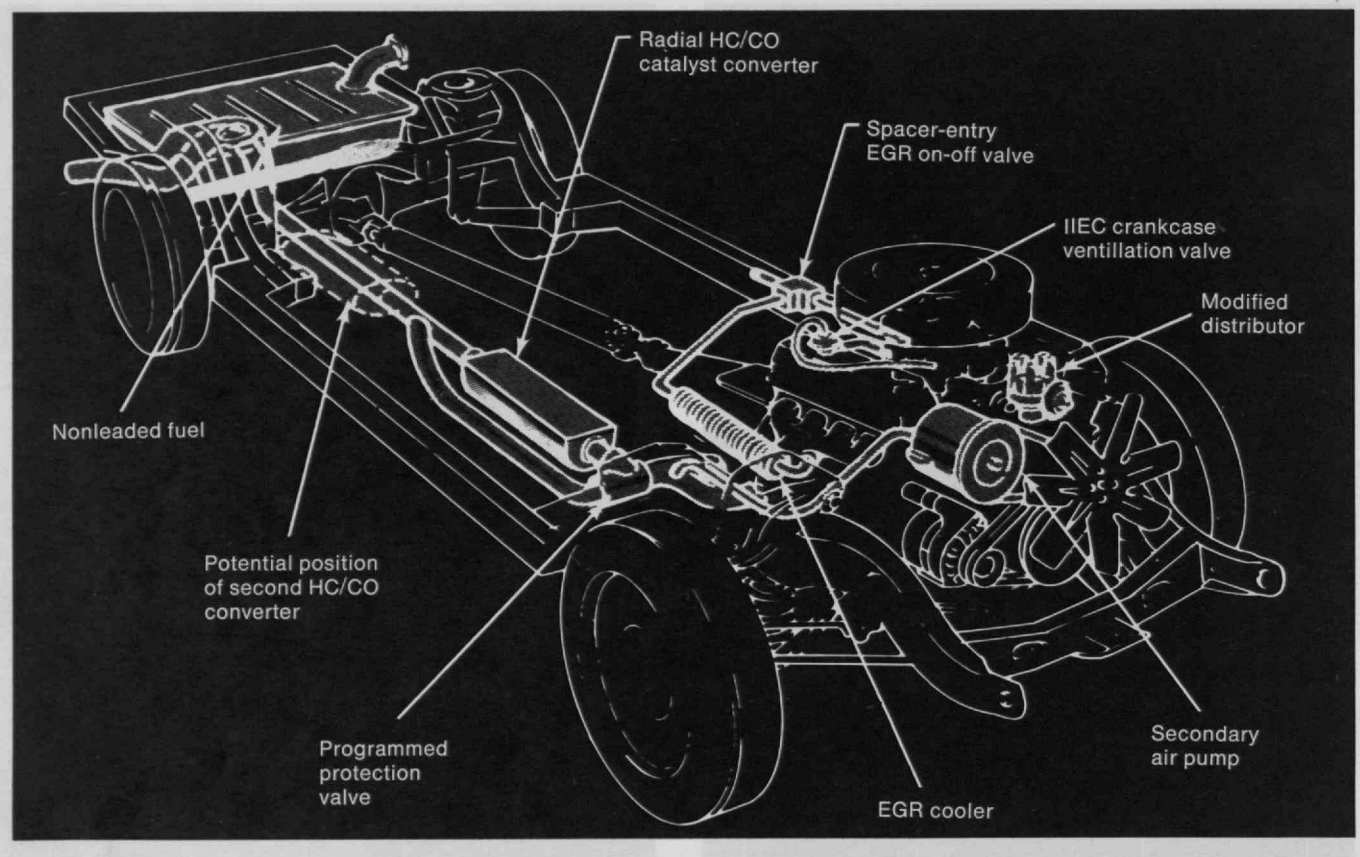
Hydrocarbons and CO will probably be controlled by optimizing engine-operating conditions—by running

The three major pollutants—hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NO_x)—form inside the engine cylinder during the combustion process. Other sources of hydrocarbons—the crankcase blow-by and fuel evaporation—have now been controlled.





1976 automobiles may incorporate many of these emission controls. The vehicle will probably be smaller than today's family-size car. It may have a slightly larger but downrated engine compared with current compacts, and fuel economy will be worse.



the engine fuel-lean during most of its operating modes, so that pollutant concentrations exiting the exhaust valve are at a minimum. Further reductions will be obtained outside the engine with afterburning devices in the exhaust system. These may be thermal reactors attached directly to the engine head or catalytic reactors mounted underneath the car. In either case, the reactors will use air added to the exhaust gases just upstream to consume the residual HC and CO emissions in the exhaust. Catalytic reactors look more promising at present, but so far they require the use of unleaded fuel to prevent poisoning of the catalyst, and this is a major factor in the current move to take lead anti-knock additives out of gasoline.

Control of NO_x is more difficult. Peak gas temperatures inside the engine cylinder must somehow be reduced, and engine performance inevitably suffers as a result. Careful control of fuel and air flow rates, spark-timing adjustments, and lower air intake temperatures all yield some reduction. One additional technique is likely as well: the recycling of about 10 per cent of cooled exhaust gas to the air intake system. This has the effect of adding an inert gas to the intake air, and for given air and fuel flows, the flame temperature goes down. Too much exhaust recycle gives poor performance, however, and fuel economy will in any case be reduced.

Catalytic converters to reduce NO_x levels in the exhaust are also being developed. So far they are less effective than the HC and CO exhaust reactors, and the NO_x reduction obtained may not be worth the extra cost.

More radical concepts are also being considered. One is the stratified-charge engine where—as the name implies—the fuel is injected directly into the cylinder to form a stratified fuel-air mixture. In a conventional internal-combustion engine, the fuel-air mixture must

be essentially uniform in composition. But in the stratified-charge concept, the nonhomogeneity is carefully controlled so that each part of the injected fuel burns under conditions that keep pollutant formation to a minimum. Afterburning reactors and exhaust gas recycle can also be used with this design to further reduce emissions.

Will these concepts enable manufacturers to meet the new 1975 standards? Certainly the automakers now have prototypes which satisfy or almost satisfy the requirements. But 10 million production models a year is a different story. Three factors are going to be immensely important: quality control, durability, and cost.

Going from Prototype to Practice

Some comments on the variability of emissions from apparently identical engines and the deterioration of emission control systems in current models have already been made. These problems result in part from the certification procedure used by the federal government. A few prototypes of the production models are tested by N.A.P.C.A. (now E.P.A.), driven through accelerated driving programs to accumulate 50,000 miles in a few months, and retested. If average emissions at 50,000 miles are below the standards, that engine is certified and the production lines can roll. It is perhaps surprising that the system works as well as it does. Production models on the road are not quite as clean as the prototypes due to poorer quality control, different road-driving histories, and inadequate maintenance. But the slippage is not too great; if hydrocarbon emissions exceed the standards by 25 per cent, as it appears they do, then for 1970 model-year vehicles the emission control achieved is a 66 per cent reduction rather than 73 per cent, compared with uncontrolled vehicles.

But the potential for deterioration in the future will be very much greater. If the different pollutants are to be between 93 and 97 per cent controlled by 1975, there is a long way to slip back. A major part of this control is going to depend on very precise engine adjustments. Quality control of component manufacture and assembly will become much more important, as will the durability of component performance and engine operating condition settings.

The Clean Air Act Amendments of 1970 require automobile manufacturers to warrant their control systems as satisfying the emission standards for 50,000 miles, and such a requirement could not really be implemented now. It will require customers to have their engine control systems serviced exactly according to manufacturers' specifications and to always use the correct gasoline; the servicing will have to be adequately performed, too. Equally, there is no way at present of knowing whether the emission standards are satisfied for each type of car, let alone each car. The full Federal Emissions Test Procedure is much too lengthy and expensive for mass use.

The responsibility of maintaining emissions control once a vehicle is on the road must eventually be shared by the manufacturer, the owner, and the state. A few states are already actively developing control programs; New Jersey, for example, is investigating simplified emissions test procedures which could be incorporated into the existing annual vehicle safety inspection. But a reliable, cheap test is a long way off, and it is not yet clear exactly how knowledge of the actual emissions of each car would be used if available. Such knowledge would identify the worst offenders; but inspection of spark plugs, timing, and fuel-air ratio adjustments would probably do that just as well. So state-required maintenance programs may be cheaper and equally effective. The emissions problem is very different from that of automobile safety; every car must be safe, but it is only the average emissions which we want reduced.

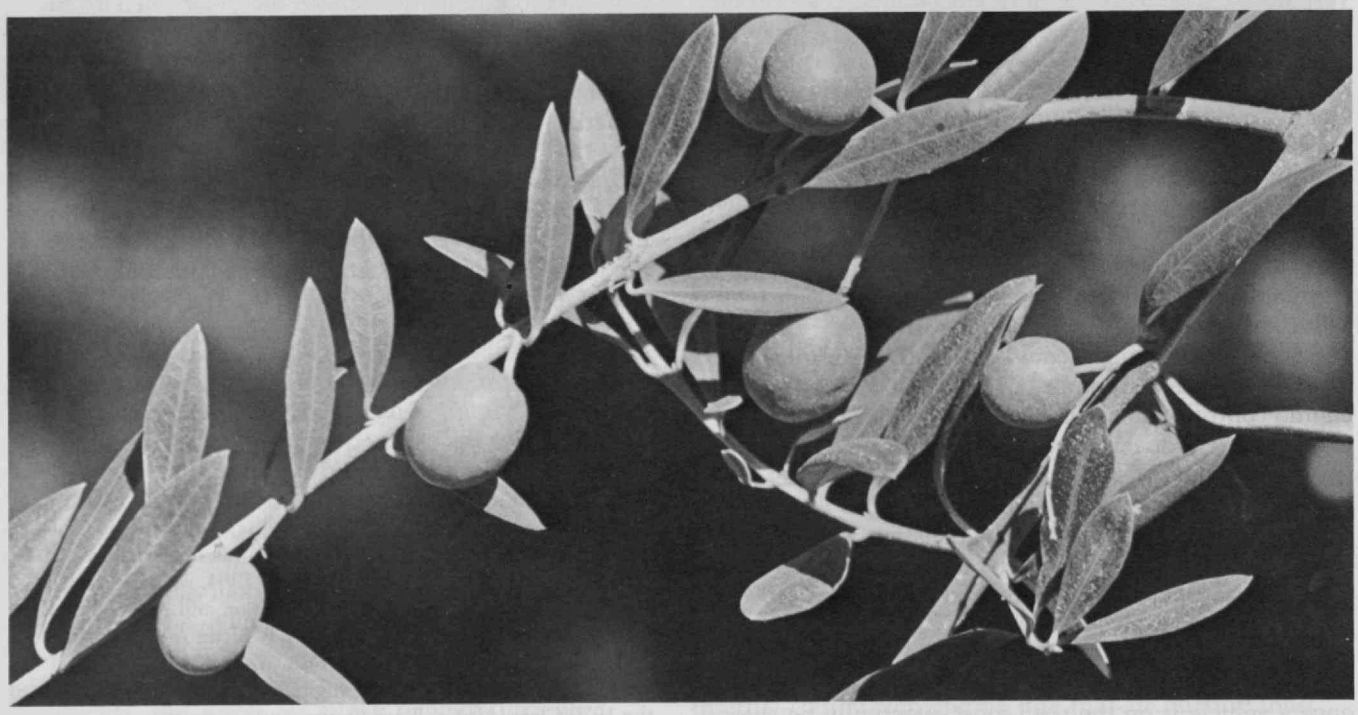
Will we as a result of all this ever have "clean" air? Emissions from new cars have already been substantially reduced through the Federal Control Program, and by the late 1970's new cars will probably be close to the new 1975-76 federal emission standards.

Even then we will not be able to simply wait for these new cars to gradually displace the older, dirtier cars. The responsibilities of owning a car in the 1970's and 1980's will clearly be more onerous and costly than they are now, if effective control systems are to be maintained.

There are many major problems to resolve along the way, but if it does all work out, emissions from automobiles by 1980 will be less than one-fifth of what they are today. Even so, the smog may never totally vanish from Los Angeles.

John B. Heywood, a native of England, is a graduate of Cambridge University (1960). He completed his doctorate in M.I.T.'s Mechanical Engineering Department in 1964, returned to England to work on M.H.D. power generation and rejoined M.I.T. in 1968. He is now directing the M.I.T. Sloan Automotive Laboratory. His current research interests are combustion and the production of air pollutants in engines. He was faculty advisor to the 1970 Clean Air Car Race Organizing Committee.

Olive trees beset by olive parlatoria scale can be restored, as in the bottom photograph, to healthy and fruitful life without chemicals. Biological control of pests, by using their natural enemies, promises to keep our food crops free of pests without endangering the environment. (Photo: Frank Skinner)



A number of natural methods of pest control, effective against some pests with little or no chemical support, can help us, for a time, to feed our growing numbers without abusing our land and the life upon it

Carl B. Huffaker
Director, International Center for Biological Control
University of California, Berkeley and Riverside

Biological Control and a Remodeled Pest Control Technology

Two pervading developments, meeting in human affairs, bring to public attention little-recognized methods of pest control and the urgency of remodeling current strategies and attitudes if insect depredations are to be controlled without serious environmental effects. A worldwide human population explosion that requires the feeding of ever larger numbers of people, and the largely consequent worldwide pollution of the environment, pose the need to solve the first problem without adding to the second. While man is indeed an earth pest, threatening the ecological base—productive soil, clean air, and clean water—that sustains life, the means by which we may limit his numbers are beyond the scope of this article. But there are methods of pest control that may solve the short-term problem of food production without adding to environmental degradation, thus buying time while a solution to the overriding problem is sought.

Advances in farming technology in this century have been monumental. Crop varieties have been much improved; technologies of pest control, cultivation, fertilization, irrigation, and harvesting of crops have added billions of pounds of food for the world's hungry. Yet weeds, insects, plant diseases, and rodents still claim substantial portions of potential yields.

Following the dramatic successes with DDT and other synthetic insecticides subsequent to World War II, control of insect pests entered an era of unilateral use of those chemicals that killed the most kinds of pests (broad-spectrum effects) and in greatest numbers, with little regard for other effects. The strategy was one of reducing each pest as it appeared, in single-purpose fashion. Clearly, this approach has had tremendous adverse effects on the quality of the environment. Official and public warnings from many quarters have not reduced the use of such chemicals. Rather, pesticide use in the United States has more than doubled in the last ten years, to about one billion pounds per year. Use of these chemicals has not even had the prolonged direct success in the control of the insect pests that was first indicated. Insect problems have not lessened; they are greater than before.

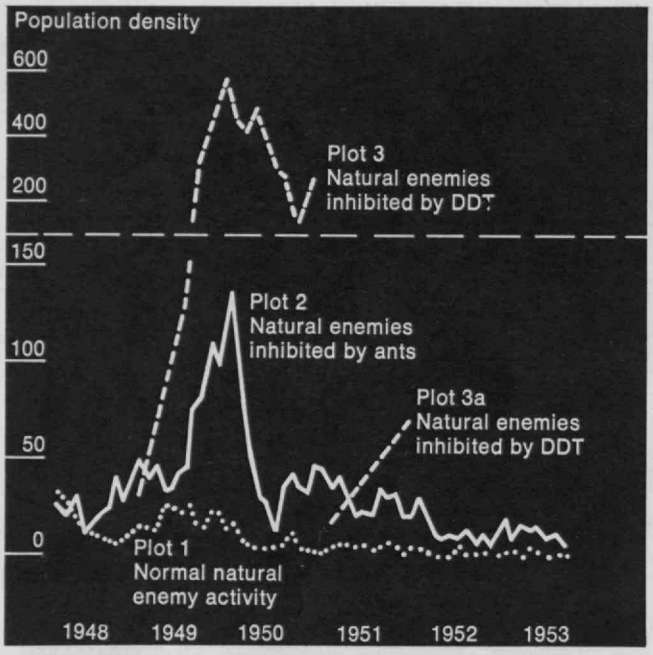
Many entomologists appeared to feel that the spray gun was the answer to every problem. We learned, in time, that organisms may counterattack and develop resistance to toxicants used against them, but it was thought that another pill could be ready when one no longer sufficed. We are now painfully aware that this is not so. Some species have become resistant or tolerant faster than new materials can be developed. More materials and heavier usage have induced new problems.

Much has been said about the adverse effects of this pesticide technology on our cherished and declining wildlife, but relatively little publicity has been given the adverse effects on the natural enemies of the pest species themselves; killing these, we inherit their work, and must prolong and intensify insecticide usage, thus further increasing the adverse effects on wildlife.

In the old approach each problem was considered in isolation from other problems of crop production and environmental quality. Yet even a simple agro-ecosystem presents a maze of interacting loops between pests; between a pest and its natural enemies; and between each of these and cultural practices, weather, soil conditions, plant variety, surrounding fauna and flora, and each organism's capacity to adapt to changed conditions. Moreover, mineral excesses may lead to eutrophication of our inland waters and soil sterility for some crops. All these factors must be viewed as an interlocking system. It is not surprising, then, that the single-purpose use of highly toxic synthetic acaricides and insecticides led to severe side effects, including quick resurgence of the pests due to destruction of their natural enemies; development of resistance to the pesticides by target species; hazards to workers in the crops, and to consumers; rise of previously innocuous species to pest status, following the removal of their natural enemies, and a consequent population explosion; and adverse effects not only on the natural enemies but on many valuable nontarget organisms and on man himself, even at great distances from the places treated.

Clearly, a realignment of objectives on a broad basis is needed. Fortunately, pest control has started to move beyond this misguided, nonecological, and single-purpose era of control by highly toxic, broad-spectrum pesticides to a more enlightened approach: integrated control. The first principle of integrated control is to focus on the ecosystem. The goal is to make the best possible use of all principles of population regulation or limitation, natural and artificial, in a multidisciplinary and closely coordinated program.

DDT is an enemy both of pests and of their natural enemies. Plot 1 describes the density of red scale on California lemon trees in experimental patches under conditions of excellent control by natural enemies. Plot 2 shows the density increase as the scale's natural enemies are inhibited by ants. Plot 3 shows the scale density as its natural enemies are inhibited by applications of DDT, which affected the growth of the scale only indirectly, by reducing the numbers of its enemies.



For example, new possibilities being explored include: biochemical stimulants inducing oviposition or attack; release not only of sterile male insects but of males that will produce sterile progeny; transplantation of genes for pesticide-resistance or cold-hardiness into the population of a useful predator lacking such; increasing the effectiveness of such a natural enemy by release of the pest species itself at critical times; and use of insect pathogens, hormones, or synthesized highly selective pesticides.

The Classic Principles—Nature's Own

Some of the classical methods are being explored with renewed emphasis and new insights. Some of the repercussions from the use of DDT and other synthetic pesticides showed us that natural enemies are key factors in the control of many, if not most, insect pests—i.e. even today, most of our "pest control" is being done gratis by natural agents (conversely almost anything can be a pest if it gets out of hand). Professors P. S. Messenger and Robert van den Bosch, of the University of California at Berkeley, have noted that introduction of specific genetic stocks of an enemy species have produced striking results where indigenous stocks have failed. Going one step further, the introduction of "new" natural enemies from exotic regions has shown a high degree of success for the efforts expended. Professor C. P. Clausen, of the University of California at Riverside, estimates that attempts have been made to control 223 species of insect pests by introduction of "new" natural enemies, of which 120 (or 55 per cent) have been at least partially successful. There are about 70 examples of complete, exclusively biological control.

Research continues to reveal a striking potential also in the development of crop varieties resistant to key pests. The early success in developing wheat varieties resistant to Hessian fly is well known. Likewise, work on corn resistant to the European corn borer, alfalfa resistant to the spotted alfalfa aphid, and cotton resistant to the boll weevil, have had considerable success, although these developments are not widely known.

The release of sterile pest species, developed by Dr. E. F. Knipling of the Agricultural Research Service, U.S. Department of Agriculture, has been shown effective in removing a single key pest at a time—the screwworm fly and some fruit flies, for example. With this method, other pests could often then be controlled by less expensive means.

Lastly, development of systems analysis and sophisticated use of computers presents possibilities not available heretofore for organizing all necessary information relating to crop production and profit, pest control, and broad environmental and economic side-effects, with their many interactions, so that rational decisions can be made as to proper strategy not only for pest control but for crop production.

Effective biological control is cheap, and is usually inherently "persistent" without frequent recurring costs; it usually cannot be quickly countered by genetic alterations in the pests; it does not cause the elevation of normally innocuous forms to pest status; it does not add to environmental pollution; and it causes no hazards to farm workers, consumers, or wildlife.

The Introduction of "New" Natural Enemies

Most of our major insect pests are aliens from foreign lands that have arrived without their natural enemies. Usually such species—like the Japanese beetle, corn borer, spotted alfalfa aphid, brown tail moth, cottony cushion scale, California red scale, and olive parlatoria scale—are not the serious pests in their native home areas that they immediately became upon their arrival here. Our best results in biological control have been with exotic natural enemies introduced to balance a previously introduced pest.

Control achieved this way is often permanent and quick. The principle is so logical, and has been so successful, that no major insect pest should remain uninvestigated. Yet, attempts have been made for only 223 species, worldwide, of the thousand or so major pests. Many attempts have been only casual or have involved use of a particular natural enemy against unsuitable species or in unsuitable environments. The possibilities for controlling the notorious codling moth in this way, or the Mexican bean beetle, or the cotton boll weevil, for example, have only been explored superficially.

Sometimes only a minimum of effort and expense is required for success; but a lack of taxonomic and other biological knowledge can result in many years of failure. The essential supplementing factor in the control of olive scale in California resulted from the coincidental collection by Professor Paul DeBach of the University of California at Riverside, of an aphelinid parasite, *Coccophagoides utilis*, in West Pakistan, and its shipment to California. Mr. C. E. Kennett, of the University of California, and I have shown that this species is secondary in value to the previously introduced *Aphytis maculicornis*, but it provided just the additional mortality of scales necessary to turn a partially successful program into one completely so, almost at once. Dr. Isaac Harpaz has also reported that the introduction of a species later determined as *Aphytis holoxanthus* from Hong Kong into Israel was remarkably simple and inexpensive, and that it led quickly to control of Israel's principal citrus pest, the Florida red scale, with an annual saving of $1 million.

On the other hand, efforts to control the California red scale in California by introductions of new natural enemies (predators and parasites) has extended over the past 70 years. Some 30 species have been introduced and colonized and at least eight have become established. For much of this time, *Aphytis chrysomphali* (apparently introduced inadvertently with the pest scale itself), was the only member of its genus present in California citrus groves. The taxonomy of the genus had not been fully worked out, so that this golden chalcid was undifferentiated from many others of the group. Very little of any value was done to introduce other species into California. Dr. DeBach has now better clarified the taxonomy of the group, and introduced a number of closely related *Aphytis* species.

Two of these, first *A. lingnanensis* from southern China and then *A. melinus* from India and Pakistan, became established. The former spread and displaced *A. chrysomphali*, quickly achieving a much improved biological control in interior and intermediate areas, and—less rapidly—in coastal areas as well. *A. lingnanensis* was not sufficiently effective in the interior areas with hotter summers and colder winters; however *A. melinus* was then introduced to cover these interior areas and the degree of control was again improved. In the Fillmore area near Los Angeles some 8,500 acres of citrus have been put under successful biological and integrated control; the reduced use of chemicals has saved half a million dollars annually.

These introductions of natural enemies of California red scale and olive scale are outstanding examples of competition between parasite species in the field, leading to displacement of the inferior species. In each case displacement is associated with improved biological control. A few of the many other examples of successful control by new natural enemies will illustrate the potentials of the method.

Cottony Cushion Scale vs. a Lady Beetle

Cottony cushion scale threatened the very life of the burgeoning citrus industry in California before the turn of the century. Imaginative men reasoned that catastrophe could be avoided if enemies from its native home could be found and introduced. This had never been done before. The pest was a serious one wherever it existed except in Australia, so Australia was assumed to be its native home. Two species, a predator—the vedalia lady beetle, *Rodolia cardinalis*—and a parasite—*Cryptochaetum iceryae*—were found there and established in California in 1888-89. The latter was regarded at first as the more promising; but it was soon overshadowed by the beetle, which completely suppressed the scale by the end of 1889. Control of the scale by introductions, mainly, of *Rodolia*, was subsequently repeated throughout the world, and the world recognized and for a time strongly supported such efforts.

In 1963, alligatorweed infested some 97,000 acres of waterways in the Southeast. The flea beetle *Agasicles* was brought in from Argentina, with the results shown in the second photograph a few years later. *Agasicles* has been introduced not only in Florida, the site below, but now also in Texas, Georgia, and Alabama.

Cryptochaetum is now dominant in coastal California; *Rodolia* is dominant in the interior. That their control is still phenomenally good was illustrated in 1946-47. DDT had been used in some groves, destroying these natural enemies. Northern California's interior groves became heavily infested with the resulting exploding population of the scale. One owner purchased 1,500 vedalia beetles at $1 each to restock his grove, and the situation was rapidly corrected. Similar examples of upsets were found in southern California, where this scale is normally very hard to find.

Other Victories by Exotic Enemies

Hawaii has had similar successes, and two recent ones are notable. The giant African snail, which a decade ago threatened destruction of a great variety of crops and ornamentals, has been controlled by importing a predatory snail that attacks it. The pest is now difficult to find, although it was once so numerous as to cause traffic hazards on occasion—the roads were slimy from run-over snails.

Puncture vine, *Tribulus terrestris,* an alien in Hawaii, has been brought under control by introductions of two weevils of the genus *Microlarinus* from Italy. One, which attacks the stems, multiplies more readily in Hawaii on a native weedy *Tribulus* than it does on *Tribulus terrestris;* moreover, it can breed there more continuously the year around. Because the enemy has a supplementary host, its pressure on *T. terrestris* has thus been more steady and more severe in Hawaii than in California, where the insects were first introduced for control of this troublesome weed.

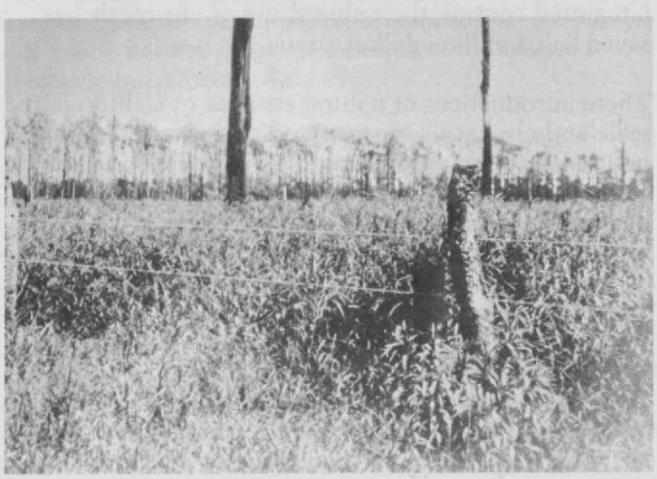
Nezara viridula, the southern green stink bug native to wide areas of the Northern Hemisphere, has recently become established in New Zealand, Australia, and Hawaii, where it caused extensive damage to a variety of crops. A tiny scelionid wasp which attacks and develops in the eggs of this bug was introduced into each of these places from Florida, and the pest subsequently greatly declined. It is said now to be so scarce in Hawaii and Australia, and perhaps also in New Zealand, that it is of no importance at all. Skeptics have said that this could not possibly be due to the parasite's activities: Mr. C. J. Davis, Hawaii's state entomologist, replied by placing scattered *Nezara*-egg batches in various habitats where both hosts and parasites were difficult to find. Most of these eggs were found and attacked by the few resident scelionids.

Australia, Texas, and More Aliens

The story of prickly pear (*Opuntia stricta*) control in Australia by *Cactoblastis* came three to four decades later, but it did for weed control what the vedalia lady beetle had done for pest insects in the 1890's—it showed that a devastating and extensive weed, that yields to no other method, may readily succumb to the attack of a natural enemy.

The immensity of the result in this case almost dwarfs imagination. These spiny cacti had by the mid-1920's completely taken over some 60 million acres of agricultural land in Queensland and New South Wales. Queensland's entire economy was threatened with ruin.

A luxuriant growth of prickly pear is shown in the top picture; the effect upon it of the moth *Cactoblastis cactorum* in the middle one. The change took three years. *Cactoblastis* proved that a weed that yields to no other kind of control may be destroyed by a natural enemy. The land was cleared and put back to use, as shown by the same field, now covered with rhodesgrass, at the bottom.



Despite intense public fear that the insects might turn to devouring grasses and vegetables, specialists introduced from the southwestern U.S.A. and from Argentina some 50 species of insect enemies. A moth, *Cactoblastis cactorum,* native to Argentina, quickly became established, and within three years dense impenetrable stands of the weed were reduced to decaying scraps. Dr. Alan Dodd of the Australian Bureau of Lands described the transformation in Queensland of 50 million acres "from stagnation under the stranglehold of the pest to thriving townships, prosperous farms growing a variety of agricultural crops, herds of dairy and beef cattle, and flocks of sheep, and the developmental improvements associated with this reclamation."

Rhodesgrass scale, an alien invader, was first found attacking rhodesgrass in Texas in 1942. Since then it has been recorded in 94 grasses in North America. The scale infests some 60,000 sq. mi. of range in southern Texas and often causes severe losses when uncontrolled. Initial studies on the use of chemicals indicated this approach utterly useless under range conditions.

An internal parasite, *Neodusmetia sangwani,* whose females are brachypterous (nearly wingless), was introduced from India in 1959. This parasite's brachypterous condition is probably an evolved asset in the wind-swept grasslands of the world, and in the absence of human activities it could probably spread readily enough to keep up with the spread of its host. What was needed was to give the parasite the same range of movement that the scale had been given (presumably by some human carrier).

Eventually, Dr. M. F. Schuster, of Texas A. & M. University found it possible to collect grass culms from range plots infested with parasitized scales and drop them from an airplane at distances of one-half to 2 miles apart—close enough to effect good coverage—for only $0.39 per acre.

Aquatic Alien Pests

Biological control of two important water weed problems has been accomplished recently. The U.S.D.A. in cooperation with the U.S. Corps of Engineers introduced a flea beetle for control of the alligatorweed, *Alternanthera phyloxeroides,* which displaces desirable water plants and clogs waterways (*see* Technology Review *for May, 1970, p. 65*). In 1967, control at certain sites in Florida was evident, and later reports suggest that due to the beetle's activities it has been possible to reduce the use of herbicides for alligatorweed control in Florida by 90 per cent.

Of perhaps greater import for the future, introduction into Puerto Rico of a plant-eating snail that can tolerate highly polluted water has been effective in control of heavy growths of water lilies, and has indirectly destroyed populations of another snail that is a host of the dreaded schistosomiasis (*see* Technology Review *for January, 1971, p. 75*). Professor Clifford Berg, of Cornell University, has studied the biologies of the principal group of insect predators and parasites (scelionid flies) of snails, and some present possibilities for direct biological control of the snail hosts of *Schistosoma.*

Natural Enemies Come in Families

Work of a rather different kind, with parasites of the walnut aphid, California red scale, olive scale, and alfalfa weevil, suggests that a great resource of natural genetic stocks of enemies has been almost untouched. In each of these cases, introductions of particular stocks of the same species of parasite, or of sibling species (undifferentiated by normal taxonomic methods), gave excellent results where other apparently identical stocks had performed poorly. For example, Professor Robert van den Bosch and his associates at Berkeley and Riverside studied the effects of two different strains of the parasite *Trioxys pallidus* in the control of the walnut aphid. A strain from France, introduced in 1959, proved a valuable agent in coastal and intermediate areas of southern California, but it failed to establish in northern California. Dr. van den Bosch imported the same species in 1968 from Iran's Central Plateau, which has a climate much like California's Central Valley. Excellent biological control has resulted in several study sites; the parasite has spread widely and promises complete control.

This example brings to mind the work of Dr. Brian Croft, who recently introduced from Washington a pesticide-resistant stock of the predatory mite *Amblyseius occidentalis* into southern California apple orchards. This stock appears to have crossed with the local stock, and the subsequent population now possesses the pesticide-resistance of the Washington variety.

Sometimes the Enemy is Disease

One of California's more recent programs involved an enemy from a much closer neighbor. That one of the enemies used was a virus showed the possibilities of control by disease. In 1941 the western grapeleaf skeletonizer became established in San Diego County. Extensive quarantine efforts were made to prevent its spread into the extensive vineyards of the rest of California. At the same time a number of natural enemies were introduced from other states. A tachinid, *Sturmia harrisinae,* from Arizona and a polyhedrosis virus disease were utilized in a campaign to see if biological control similar to that prevailing in Arizona could be effected. The effort was so successful that the quarantine has been lifted.

This example again calls to mind another: the Canadian success in curtailing the devastating outbreaks of the European spruce sawfly in the Maritime Provinces, by accidental introduction of a polyhedrosis virus disease and deliberate introduction of parasites from the sawfly's European home area.

Only one pathogen, *Bacillus thuringiensis,* has been widely registered for use on food crops, but work is under way to develop a number of others, including several viruses. A recently discovered granulosis virus of the key pest of apples, codling moth, shows promise.

Control by Resident Natural Enemies

Biological control by resident natural enemies has had relatively little support, but it promises much for the future. New insights have been gained in recent dec-

ades, and some important breakthroughs in mass production techniques have been made. This approach looks especially promising when one recognizes that the great majority of our indigenous plant-feeding species are under biological control much or most of the time, and become serious pests only when disturbances are imposed, by chemical treatments or in other ways.

"The totality of actual and potential pests in a crop can be thought of as a pyramidal iceberg," Dr. DeBach says. "The actual pests (which lack effective enemies) show above the surface and bring ready recognition; the *potential* pests (which represent 80 to 90 per cent of the whole) are hidden and will remain hidden and innocuous if their natural enemies are not decimated." The disturbing effects of pesticides on natural enemies can be either direct or quite subtle; many at least of the extensive worldwide outbreaks of spider mites in the 1950's and continuing today resulted from adverse effects of modern insecticides on their natural enemies.

Three main avenues for improving the results from resident natural enemies are habitat diversification, the supply of supplemental resources, and the release of additional numbers of the natural enemies (not necessarily very large numbers).

Habitat diversification is classically illustrated by the fascinating work of Professor R. L. Doutt in California's San Joaquin Valley. He showed that biological control of the native grape leafhopper, which was for many years the principal grape pest in extensive areas, can be accomplished through habitat diversification.

In certain locations, the growers never had to use pesticides to control this species, whereas in most vineyards there were heavy treatment programs and yet the problem was ever present. A tiny egg parasite, *Anagrus epos,* parasitized the eggs of the leafhopper in these untreated vineyards, and very few young leafhoppers developed. These vineyards were all located along streams. However, this leafhopper does not overwinter in the egg stage, and the parasites could not be found overwintering in the vineyards as adult wasps. Studies in the native riverine haunts, where the leafhopper's only original host—wild grape—grows, revealed that the parasite does overwinter there, but as immature parasites in the eggs of still another leafhopper, *Dikrella cruentata,* which is found not on grapes but on evergreen native blackberries that grow in association with the wild grapes. Planting of very small patches of evergreen blackberries near vineyards located miles away from riverine sources of native blackberries permits survival of the parasite on its alternate winter host. In the spring they move readily, up to three miles, into surrounding vineyards lacking them. Thus, the outlines are clear for a very promising and highly rewarding scheme for control of this serious pest in California.

Dr. F. R. Lawson, of the U.S.D.A., increased predation on hornworms by *Polistes* wasps in North Carolina by adding boxes for their nest building, a technique that has also been used successfully to increase bird predation on a number of forest insects.

The dreaded Klamath weed, or St. Johnswort, took over several million acres of land in California before the beetle *Chrysolina quadrigemina* was brought in to tame it. The top picture shows a field still half in flower with the weed; the beetle has killed the back half. The same field was overgrown with grass in 1950, two years later. The third picture, in 1966, shows the control to be still effective. The ranching industry erected a monument to its savior beetle. (Photos: J. K. Holloway and Junji Hamai)

Habitat diversification has also been used in Peru to increase parasitization and predation on *Heliothis* in cotton fields through interplanting with strips of corn, and in California control of *Lygus* bugs in cotton has been facilitated by interplanting strips of alfalfa as a trap crop (*see* Technology Review *for April, 1970, p. 75*). Analogous techniques have been successful in various parts of the world.

Sometimes the strategic addition of the pest itself as a food resource for the enemy is effective. Mr. Kennett and I aided the success of cyclamen mite predators in young strawberry fields by stocking also the cyclamen mite. Control of the imported cabbage worm on field cabbage in Missouri was not effective because this butterfly has a period in summer when it is not breeding and not in proper stages to be attacked by the parasite *Apanteles glomeratus*. Consequently, the parasites die out and outbreaks of the cabbage worms occur again in the fall. By releasing only small numbers of insectary-reared reproducing butterflies in mid summer, Dr. Frank Parker, of the U.S.D.A., obtained good control of the pest—and grade-A cabbages at marketing. Dr. Parker also has obtained similar results through strategic releases of cabbage loopers, thus increasing in this case the effectiveness of a virus.

Professor K. S. Hagen, of the University of California at Berkeley, has pioneered the field addition of highly nutritious and attractive food supplements to increase natural enemy effectiveness. The technique is currently promising in the control of bollworm on cotton in California.

Chemical Supplements

Supplementary chemical controls are sometimes, if not commonly, used against one or more of a crop's pests. The success against Florida red scale in Israel by *Aphytis holoxanthus* was described above. For the parasite to be effective, however, changes were necessary in the insecticide treatments being used on the citrus against two other pests, the Mediterranean fruit fly and the citrus rust mite. Instead of the usual full-coverage sprays of chlorinated hydrocarbons for the fly, strip sprays of an attractive poison bait were used, and found to be so superior to the former method that exported fruits no longer had to be treated by fumigation or dipping, further reducing costs.

At the same time it was found that the sulfur and dicofol previously used to control the rust mite were having adverse effects on the predators of the mite itself. A shift to such materials as Zineb was made and with this change, plus the beneficial effects from no longer using the chemicals formerly used for the scales and fruit fly control, the rust mite steadily declined—and is no longer of major economic importance.

Some Changes That Are Needed

Some changes need to be effected before our control of pests will be economic and ecologically sound. First, we need to establish what pests are real ones and at what densities, and what pests are induced by pesticides themselves or are pests that cause only superficial blemishes of a "cosmetic" nature not affecting real quality. Discrimination between levels of economic injury has been neglected. Pesticide treatment schedules have commonly been based on calendar dates, without reference to population levels, and for almost no species are economic threshold densities established.

Second, we need a rebirth of the biological or ecological approach to the whole question of pests—so that maximum use can be made of cultural and supportive measures of control.

Third, we need to learn the full potential of our resident natural enemies for control of our pests, why certain ones are inadequate, and whether or not we can correct this, and, in any event, we need to place a major emphasis on introduction of new natural enemies.

Fourth, we need to look on our use of pesticides as a measure to supplement selective ecological methods—using them selectively in minimum amount and with minimum adverse effects.

Fifth, we need much new research to develop all selective and ecologically compatible avenues of pest population limitation, and to explore their integration into a multidisciplinary systems approach to strategy and tactics for both pest control and crop production. These methods include greater research emphasis on use of pest-resistant varieties of plants, on genetic approaches, on hormones and pheromones for control of certain key pests, and on the significance of population interactions.

Sixth, we need to reshape public attitudes about acceptance of produce that is of high quality but may bear blemishes or negligible presence of insects or insect parts.

Seventh, we need to develop a field working corps of pest control ecologists to replace the pesticide salesman as a principal source of the grower's pest control advice. These specialists should work for the growers, not the pesticide company, and charge a fee for their advice *not to treat* as well as to *treat*, and an examination and licensing system should be established to assure competence.

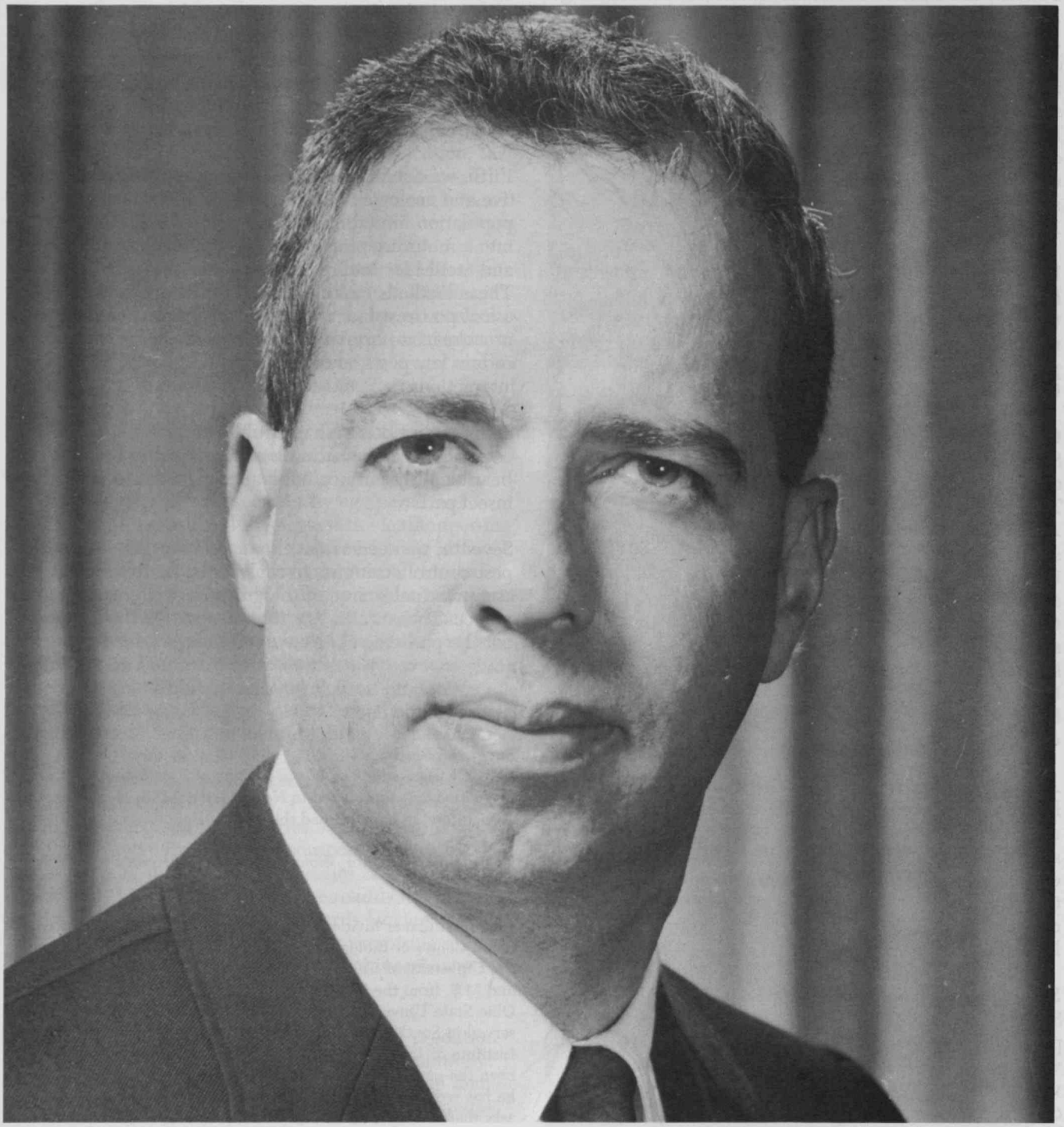
Suggested Readings

C. P. Clausen, editor, *A World Review of Parasites, Predators and Pathogens Introduced to New Habitats*. U.S. Department of Agriculture, to be published this year.

C. B. Huffaker, editor, *Biological Control*, Plenum Press, New York, 1971.

Carl B. Huffaker divides his time between directing the International Center of Biological Control and teaching entomology at the University of California (Berkeley). He received his B.A. and M.S. from the University of Tennessee, and his Ph.D. from Ohio State University. Before joining the Berkeley faculty, he served in South and Central America as an entomologist with the Institute of Inter-American affairs. His special interests have been the natural mechanisms controlling population growth, and he has written widely during the past 25 years. Dr. Huffaker asks that correspondence be addressed to him at the Center, 1050 San Pablo Avenue, Albany, Calif. 94706.

Technology will make "new and intensified demands on international machinery [which] will severely strain the international political system as we know it today. Serious questions arise as to the viability of existing patterns of international relationships. Whether man and his political systems are capable of coming to grips with these prosaic but politically demanding requirements will go a long way to determining whether we ever have to worry seriously about global catastrophes."



A growing number of technologies operate or have effects in the global arena. A multitude of worldwide regulatory tasks present themselves

Eugene B. Skolnikoff
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Technology and the Future Growth of International Organizations

In any attempt to foresee the large-scale effects of new technology, there is always the temptation to take a cataclysmic view of the future, and to predict dire consequences if major political changes are not immediately made. Such an approach, of which there are many examples in the literature today, rarely leads to useful prescriptions for action. What is required is a sober examination in detail of the implications of technology for international political action, in order to bring the policy requirements into reasonable focus.

Such an approach is not adequate if, in fact, the technical situation really does imply catastrophe around the next corner. In my judgment, the facts imply not catastrophe, but uncertainty. The first need is to understand very much better our global environment and the effects of our technologically related insults to that environment; only then will we know whether cataclysm is in the offing, and if so what must be done about it.

In the meantime, we can look ahead to the 1980's and lay out quite clearly some of the technological developments, and their side effects, that we can see will require international action—"action" that includes regulation, systems management, enforcement, and resource allocation.

In fact, these new and intensified demands on international machinery will severely strain the international political system as we know it today. Serious questions arise as to the viability of existing patterns of international relationships. Whether man and his political systems are capable of coming to grips with these prosaic but politically demanding requirements will go a long way to determining whether we ever have to worry seriously about global catastrophes.

What follows is a partial survey of developments in technology and their side effects over the next 10 to 20 years, for the purpose of laying out the international political functions that each technical prospect implies. The developments will be selected, of course, according to their significance for the international scene, but no attempt will be made to include all relevant possibilities. In particular, developments in military technology will be largely ignored, since they are already receiving extensive attention. In addition, questions of transfer of technology to developing countries will not be considered in any substantial way.

Of necessity, the categorization of areas in which technological developments will be pertinent is largely arbitrary; increasingly, issues cut across such physical boundaries as the oceans, the atmosphere, and the environment generally. The implications, problems, and opportunities of each area cannot be seen in isolation.

This interpenetration will become more evident in the future. And in that observation there are, of course, important implications for the organization of the international system.

Environmental Alteration

This is perhaps the newest major field of human activity to come to sharp public and political attention. Suddenly, governments, at least those of the developed world, find themselves under growing pressure to protect "the environment," to avoid or prevent actions public or private that will in some sense despoil the existing physical setting. Essentially every international organization is directly involved in some way; for a few, it is becoming a significant part of their activities.

The actual subject of environmental alteration is a potpourri of different sciences and technologies, difficult to disentangle. The best course is to consider the subject in rough categories of major interest: weather and climate modification (intentional and inadvertent), large-scale single actions, and pollution.

Weather and climate modification: Man's long quest for climate control is finally moving out of the realm of fantasy. Unfortunately, at the same time, a host of side effects from other of man's activities are threatening to alter weather and climate in unplanned and potentially catastrophic ways.

Developments of technology for the deliberate manipulation of the weather can be thought of conveniently in three categories: micromodification, modification of storms, and large-scale climatic modification. Separate, but merging into mainly the last category, is the inadvertent modification of weather or climate.

First, micromodification: The experimental evidence from cloud-seeding experiments suggests that rainfall can be increased locally by 5 to 20 per cent. T. F. Malone anticipates that by 1990, "the probability is high that rainfall several hundred miles downwind from the site of the operations can be increased or

"Bold schemes for melting the Arctic ice cap [are on the horizon]. . . . The resources required for such a project may not be beyond the capabilities of a single large state. Moreover, the incentive to proceed could be enormous. And what international machinery does the world have to say that such a project cannot be 'allowed' to proceed?"

decreased at will." It takes only a little imagination to anticipate the problems that are sure to arise within countries and between adjacent or nearby countries with regard to water distribution.

Eventually, the question will emerge of how to allocate what will be, in effect, a finite resource of atmosphere-borne fresh water supplies.

With regard to modification of storms, we again find a potential operational capability. The most immediate and interesting is the prospect of being able to divert or suppress hurricanes.

An ability to modify major storms looks desirable, of course, in the light of the extensive damage they cause. But such an ability raises rather important technical and international issues. First, tropical storms bred in the Caribbean are a major source of water for parts of the U.S. and the Caribbean region; thus, suppression of storms will be costly. Second, if it were even suspected that modification (i.e. strength-reduction) activities had also deflected the *course* of the hurricane, legal claims for damage or water deprivation could result. Lastly, hurricane modification activities must in any case necessarily be carried out in an international environment—even, at times, over several different national territories.

The feasibility of intentionally modifying climate on a large scale is probably too far in the future yet to be a candidate for planning. On the horizon, however, are bold schemes for melting the Arctic ice cap, with the intention of providing increased moisture for the vast Siberian region. The actual effects of removing part of the Arctic ice cover are not agreed upon; some predict catastrophic results from such a step. But it must be realized that, even now, the resources required for such a project may not be beyond the capabilities of a single large state (a Bering Straits dam—one method—is entirely feasible at costs comparable to large continental dams). Moreover, the incentive to proceed could be enormous. And what international machinery does the world have to say that such a project cannot be "allowed" to proceed?

Other points about weather modification technology as a whole cannot be ignored. These technologies can lead to strategic or tactical military capabilities; and, even more persuasively, could be used as weapons in economic warfare through diversion of water needed for agriculture, power, or the economy generally. Which kinds of goals will predominate—beneficial or aggressive—may depend critically on the international means developed for controlling the technology.

A more hopeful observation is that climatic technology depends directly on increased scientific understanding of the atmosphere. The relevant research is being carried out mainly under two international programs associated with the World Meteorological Organization and the International Council of Scientific Unions (the World Weather Watch and G.A.R.P.—the Global Atmospheric Research Program). These two related

programs, when they are farther along, may themselves create important requirements for new or revised international machinery. But most important for the long run is the hope that the international character of the research will make later international regulation and control more feasible.

The inadvertent modification of weather and climate resulting from the rapid alteration of the earth's surface and the dispersion of wastes of all kinds into the atmosphere is a clear possibility. The most general kind of global change relevant to climate is the alteration of the planet's radiation balance. What becomes evident upon examination of the present state of knowledge is that the world could be heading for a major catastrophe, but there is neither enough information about what is actually happening, nor enough understanding of the environment, to be sure. The danger period may well be in the years with which we are concerned here; or at least, quite evident by then.

What are the functional implications of these possibilities of deliberate or accidental changes in weather and climate?

Obviously, the first need is for more and better observation, and detailed research and analysis. We must know better what, in fact, is happening. The need for global monitoring is finally becoming widely accepted. Several new national and international programs are now being planned.

As regards deliberate weather modification, this technology calls for some form of international machinery to provide the mechanism for regulation and control. Rules by which the technology can be applied will be needed; formal agreements will have to be negotiated; continuing means for monitoring, for assuring equity, for allocating increasingly scarce water resources, will be necessary; dispute-settlement machinery will be needed; conceivably, international operation of the technology itself will prove desirable.

With regard to the inadvertent modification of weather, through pollution and other man-made effects, there is a strong probability that further data and analysis will eventually indicate a need for severe strictures upon the production, anywhere, of a wide variety of air pollutants, because of their global effects. The creation of international norms and their enforcement will be a difficult process, for the ultimate effects of specific pollutants will not be obvious, the calculations are likely always to be in dispute, the controls may have to be directed at seemingly inoffensive particulate matter, and the measures required may be technically and economically onerous. It is even possible that eventually there will be a need for some kind of regulation of each nation's alteration of the earth's albedo (the percentage of the solar energy reaching the earth's surface that is reflected back into space), a fundamental variable which is affected by, among other things, land use.

Monitoring of atmospheric standards will be a major and politically difficult requirement; an appeals mechanism would also be necessary, to challenge regulations considered unfair, to question allocation decisions, and to provide a check on the "regulators."

Large-scale single actions: Never before has man had the physical power to intervene in the global and even extraterrestrial environment that he now possesses. And this physical power, restricted so far to a few nations, will "proliferate" to more and more countries in the future.

The world has already seen several dramatic illustrations of large-scale single actions with substantial, or potentially substantial, global environmental effects: fallout from atmospheric atomic tests; high-altitude nuclear tests, conducted by both the U.S. and the Soviet Union; and the placing in orbit by the U.S. of a belt of copper filaments for a military communications experiment. The latter two are particularly interesting, for they illustrate the kinds of problems these capabilities raise.

In the case of both the U.S. high-altitude nuclear shots—called Project Starfish—and the copper filament experiment—Project Westford—advance notice of the experiments was given by the U.S. government. In both cases, extensive analysis was made within the U.S. of the predicted long- and short-term effects of the experiments. In the Westford case, in fact, the U.S. government made rather impressive efforts to publicize the analysis in advance, and to encourage scientists in other countries to make their own analysis. This did not prevent a substantial negative reaction to the proposed U.S. actions from parts of the international scientific community, and particularly from the astronomers.

The Westford experiment turned out to follow the predictions exactly: the immediate effects were minor, and the filaments have fallen out of orbit as expected. But the same cannot be said for Project Starfish, conducted in July, 1962. There were substantial effects that did not accord with the prediction: some of the released electrons became trapped in the earth's magnetic field, with some long-lasting measurable effects.

Two points deserve to be noted about these examples. One is that the scientific analysis prior to the experiments was not infallible. The other is that the U.S. government, even though it demonstrated a surprising degree of responsibility in allowing prior publication and analysis of security-related experiments, was still prepared to proceed unilaterally in the face of doubts raised by the worldwide scientific community, and in the face of the knowledge that miscalculations would affect the entire globe. A more recent example of a similar situation was the underground nuclear explosion at the Aleutian island of Amchitka in 1969, where larger underground explosions are now being planned.

Several lessons about the future requirements for international machinery emerge. One is that it is essential that we know more about geophysical processes, both to know what is "safe" to do, to know better

"The costs of controlling some industrial wastes will fall unequally. Who should pay—the producer, the consumer, or the nations most offended by the particular pollutant? A nation's competitive position in international trade may be substantially affected by the measures it must take. Regulation must therefore be in some sense international simply to maintain fair competition. But what is 'fair'?"

what is happening naturally, and to plan for the full scale of the effects that will follow specific large-scale actions.

Second, some kind of internationally accepted capability will be increasingly required for assessing the large-scale plans of nations. The closer such an assessment agency comes to being genuinely international, with its decisions adhered to either by precedent or by treaty (or by force majeure), the more necessary it will be to develop ancillary mechanisms for appeal, adjudication, monitoring, enforcement and assessment of damages and claims.

In some cases, it may be necessary to contemplate international responsibility for, or even international operation of, some large-scale actions, as a way of guaranteeing equitable distribution of benefits and concern for possible harmful side effects.

It is perhaps unnecessary to add that the willingness of the present U.S. government to establish the precedent of unilateral decision on such major actions as the Amchitka tests may well come back to haunt us, as this kind of physical power becomes more widely dispersed.

Pollution: The needs and the wastes of society both grow at exponential rates. An expected world population close to 5.0 billion (by 1985) would lead to more than a 40 per cent increase in requirements for food, energy, and natural resources just to maintain the present economic levels, unsatisfactory as they are for much of the population. In fact, these requirements will be substantially increased by economic growth in all countries, and by the corresponding increase in industrialization. To meet these requirements it will be necessary to use massive quantities of fertilizers and insecticides, transport and burn larger quantities of fuel, dispose of more agricultural and industrial waste, transform more agricultural land into houses and highways, cut down more forests, find more fresh water supplies, and so forth.

In gross terms, that is the magnitude of the problem. It is not a single problem, but an enormously complicated interrelationship. The implications of a change in one aspect cannot be seen adequately or approached adequately without consideration of the rest.

In a brief essay, the detailed parameters cannot be spelled out, though the broad outlines are now familiar: the need for DDT for health and food, but its potentially catastrophic effects on animal life; the need for fertilizer to produce adequate amounts of food, but its effects on the eutrophication of bodies of water; the atmospheric effects of industrial effluents, discussed earlier; the dangers of large-scale oil-spills arising from the transport of needed fuel in huge tankers; the radiation, waste-disposal and security problems associated with nuclear power plants; and so forth.

The kinds of functions that will have to be carried out at an international level as a result of pollution-related

issues can be easily sketched:

1) Research, analysis, and information about the changing environment are needed rather desperately.

The goals are several:
a) simply to know on a continuing basis what, in fact, is going on;
b) to determine the likely effects of present trends, and to establish tolerances;
c) to develop alternatives to, or modifications of, current practices when necessary; and
d) to establish hard data on the costs and benefits of alternative courses of action, for political decision.

This is clearly the most immediate set of requirements, and one that has been recognized now by many international organizations (*see* Problems of the Human Environment, *Report of the United Nations Secretary-General,* document E/4667, which lays out the general objectives of the U.S. Conference on the Human Environment to be held in Sweden in 1972.)

2) Developing the information is the (politically) easy part of the job. It is the implications of the information for further action that will prove more difficult:

Much of the task of controlling pollution will be a national responsibility; but there will also be substantial, and growing, needs for international action. At the least there is a need for establishing international norms for effluents with global effects, for solid waste disposal, for tanker routing, for actions in the event of ship accidents, and so forth. This need for international norms will be most obvious, and will be relatively easily met, when the pollutants clearly cross national borders.

Where the pollution has more subtle effects, and requires for its amelioration unaccustomed domestic limitations in certain fields, the political problems will be more serious—for example, if limitations must be established for the total annual discharge of specific pollutants, or if certain technologies must be banned altogether, or their use rationed.

3) Limitations on research and development itself may even become a serious issue for political action, if a judgment can be made that a prospective technology could seriously exacerbate environmental problems. The prospective technology of nuclear excavation, and the actual technology of supersonic aviation, are candidates for possible limitation.

4) Creation of norms implies other functions as well—in particular, the allocation of costs and benefits. The setting of standards, or the banning of the use of certain technologies, will not affect all nations equally. The costs of giving up or replacing some pesticides and herbicides will not be measured in dollar terms only, but also in terms of human life and health. How is equity to be established?

Similarly, the costs of controlling some industrial wastes will fall unequally. Who should pay—the producer, the consumer, or the nations most offended by the particular pollutant? A nation's competitive position in international trade may be substantially affected by the measures it must take. Regulation must therefore be in some sense international simply to maintain fair competition. But what is "fair"?

5) In turn, such an allocation function requires an appeals and adjudicatory mechanism.

6) Capabilities for technical evaluation that are recognized as being fair and impartial will be essential.

7) A damage assessment and claim procedure will also be a necessity, to settle after-the-fact claims of violation of the international standards.

8) Finally, a monitoring and enforcement procedure is implied, to insure compliance. This could continue to be "passive," as is generally the case now, in the sense that nations tend to conform to standards on their own volition on the basis of a calculation of their own best interests. Or, it may be necessary to devise more powerful, and inevitably more contentious, means of ensuring compliance. Obviously, the latter requirement will pose in a direct way some of the most serious challenges to national sovereignty.

The Oceans

The oceans were the focus of the first attempts at codifying international law. Today they are a major area for the application of new technology, and as a result the cause of much rethinking and reshaping of international law. (A major new conference on legal regimes for the oceans is planned for 1973.) We need mention briefly only the two major aspects that must be dealt with: the resources of the seabed, and the living resources of the sea itself.

Mineral and organic resources of the seabed: It is thought that the world's greatest supplies of fossil fuels are likely to be found under the seabed, and particularly under the continental rise (the final section of continental land before reaching the sea floor—generally deeper than 3,000 m.). Other resources of the seabottom are also of potential interest, particularly manganese, nickel, copper, sulphur, gold, tin, platinum and the "detrital" minerals (sand and gravel). At present, except marginally for sand and gravel, the alternative sources of supply on land seem sufficient to preclude rapid economic exploitation of these undersea minerals, by contrast with oil and gas.

The major international questions, of course, have to do with who owns these resources, and thus has rights to their benefits. The Convention on the Continental Shelf of 1958 gives each coastal state sovereign rights for the purpose of exploration and exploitation. The shelf is defined as "the seabed and subsoil . . . to a depth of 200 m. or, beyond that limit, where the depth of the superjacent waters admits of the exploitation of the natural resources of the said area. . . ." In other words, if you have the technology to go deeper, it is yours.

"Whole fields of human activity will come to depend on (artificial satellite) systems once they are in operation. For reasons of equitability and political dependability, therefore, there will be strong pressure that these systems be internationally run, with the users assured of a voice in their ownership and management."

Whether the existing convention remains in force, or some modification is eventually agreed to (the U.S. has proposed, surprisingly, international ownership beyond 200 m.), one can hypothesize the kind of international functions that may have to be performed if private or public interests are to be able to exploit the resources of the seabed with relative security of investment, and if demands for equitable distribution of benefits are to be satisfied.

In essence, the primary question is again that of allocation and benefits. Assuming any resolution of the limitations of sovereignty other than a simple division of the entire oceans among coastal states (which is most unlikely, since it would not conform with present political realities: Russia would get little; Britain, a new empire based on her island possessions), some kind of regime will have to be established for unassigned areas. This regime would not only have to have a means of deciding who has access to what portions of the seabed and under what conditions, but also a procedure for distributing whatever benefits accrue. Some form of licensing authority will be involved, whose work will entail establishing criteria and making choices. If revenue-payments are agreed to, the problem of allocating these receipts must also be tackled. Monitoring, settlement of disputes, and possibly operational responsibilities will also have to be undertaken by the international regime.

Living resources of the sea: The major concern with regard to the sea's living resources is the trends in present fishing practices and technology in relation to the maximizing of yields. It is a controversial issue, but some scientists do not estimate the potential harvest of the sea to be very much greater than the present harvest, about 60 million metric tons per year. Any attempts at really improving the total catch will depend not only on improved technology; they will depend directly on more ecological knowledge, more efficient fishery methods, controlled competition, and conservation. In fact, improved technology and greater fishing effort, uncontrolled, would lead only to depletion of fish resources. It is almost certain that by the 1980's total catch limits will have to be imposed on essentially all species of commercially important fish (as is already the case for several fish species, by agreement in the relevant Fisheries Commissions).

Thus, for fisheries regulation, one sees the same basic functions as for seabed resources. To obtain the protein that the world's population needs, and to prevent the serious depletion of species endangered by overfishing, may well require the limitation of fishing rights on the high seas, and hence create the need for the conscious allocation of a scarce resource.

Outer Space

Interest in receiving economic returns from space, and in minimizing the costs by sharing, will undoubtedly grow. The likely developments can be most usefully presented in terms of their applications.

Meteorology: There will soon be in existence, as I have mentioned, two major international programs probing

the atmosphere: the World Weather Watch, and the Global Atmospheric Research Program. Both will employ, among other sensors, weather satellites. These programs, and follow-on operational programs, will have two immediate effects related to resource availability: they will add to the demand for radio frequencies, and they will require "orbital space," which may be scarce if geostationary orbits are needed.

Of greater long-range significance is the fact that as weather forecasting improves there will be an increased degree of dependence on the forecasts, until they become an essential element in many societal activities, especially related to agriculture. The space portion of a worldwide weather-monitoring system will inevitably be a major component of the system.

Forestry, agriculture, geography: Satellite applications that can assist in the planning and management of forestry and agriculture activities are almost certain developments during the time period of interest. Once again, such services are quite likely to become essential, once they have been proven and adopted as a regular input to a nation's economic system; and they too will add to the pressure on the frequency spectrum for communications, and may also require orbital slots.

Resource mapping: It is quite likely that satellites will be useful in prospecting for minerals, at least to the extent of identifying highly promising locations for ground exploration. Such information may have considerable economic and strategic interest, raising troublesome international questions about information control and access, and control of the use of this technology.

Communications satellites: Orbiting communications relays will grow substantially in channel capacity, and are likely to be increasingly sophisticated, with well-defined geographical coverage, increased power, and specialized capabilities.

Once again, the demand for frequencies will add enormously to the problems of spectrum allocation. And, since communications satellites will mostly be in geostationary orbits (to minimize the costs of the ground terminals) the pressure on available parking spaces in that narrow band around the equator 22,300 miles up will sharply increase.

Direct broadcasting: The U.N. Working Group on Direct Broadcast Satellites estimates that direct broadcast into community, or augmented home, receivers will be technically feasible by 1975. The actual development of direct broadcast systems will depend on complex economic, political, and technical criteria. For example, the preferred modulation scheme for satellite TV (preferred in order to reduce satellite power requirements) would not be receivable by most TV sets in existence today. And the cost is high: India has 500,000 villages, so one set per village at $300 per set comes to $150 million; nevertheless India and the U.S. are proceeding on a one-year experiment to be conducted in the next few years.

"Spillover" of broadcasts outside national borders, and thus some reception of "unwanted" programs, is inevitable. The frequency allocation problems associated with direct broadcast will also be substantial, since wide bandwidth is required for TV. In fact, the resolution of the frequency allocation problem will be a large determinant of the economic interest of such systems in the time period of this study.

Navigation and traffic control: Expansion in air transportation, as well as introduction of high-speed marine transport, will require greatly improved navigation aids, a need very much in evidence today on transatlantic air routes. Satellite navigation systems are likely to offer the most attractive answer to such needs, and experiments are proceeding now to determine the most desirable technological choices.

The functional implications of these satellite technologies stand out quite clearly, and, in fact, have already resulted in the creation of several new institutions on the international scene, most notably INTELSAT, the consortium for communications satellites, and the European cooperative space research and launcher development organizations ESRO and ELDO.

1) The first functional international requirement will be operating mechanisms for many of the systems mentioned above. In most cases, national ownership and operation will not be adequate as a permanent arrangement, for politically related reasons; in any case, if nationally owned, such systems would depend crucially on international cooperation.

2) Some of the information generated by the space capabilities will have large economic and even strategic consequences. Important questions about the ownership of the information, its availability to national or commercial interests, and the basis on which it is distributed, will have to be dealt with by international means.

3) Whole fields of human activity will come to depend on some of the systems once they are in operation. For reasons of equitability and political dependability, therefore, there will be strong pressure that these systems be internationally run, with the users assured of a voice in their ownership and management.

4) Many of the systems may involve differential costs of application to some portions of the globe, and differential benefits, as, for example, communications satellites. Questions of allocation of benefits and costs, and of pricing policy, will therefore have to be dealt with by international machinery.

5) Some systems may have a profit potential, or at least seriously affect the profit potential of land-based competitors. Complex problems of equity will therefore arise, and will have to be settled through international negotiation, mediation, or adjudication.

6) The development of the systems themselves creates opportunities for lucrative R and D contracts.

"We are talking here of issues that are so pervasive in society, that cut across so many of the direct concerns of individuals and interest groups, that it is hard to believe that governments will ever be able to speak with a single voice in these matters. . . . In the technologically related societal issues with which we are concerned, nations today speak with a plurality of voices. This situation is likely to be intensified rather than moderated."

The desire of many nations to share in the economic and technological benefits of the development and production of satellites is evident in present competing communication satellite proposals; an effort is being made to please INTELSAT's multinational membership by multinational subcontracting.

7) Interest in spreading the costs of space development and exploration is likely to encourage more international cooperative space efforts than are seen today, possibly requiring new international machinery.

8) Direct-broadcast satellites will raise thorny problems: setting of technical standards for the satellites themselves, reconsideration of TV standards, regulation of broadcast coverage and interference (including jamming), frequency and orbit allocation, and, of course, program content censoring.

9) Greatly increased activity in the near-earth environment will generate a requirement for a space regime capable of establishing norms and of making allocations among contemplated uses. The existing and potential military uses of space (essentially surveillance, communications, and tracking) will greatly complicate that task, but make it of even greater importance. Two of these regulatory problems stand out: (a) competition for frequencies will be sharply increased; (b) the demand for geostationary orbits will, without regulation and allocation, exceed available space.

In general . . .

I have had room only to deal with three broad topics—environment alteration, ocean resources, and outer space. This has left much unsaid concerning other, albeit related, major subjects: notably natural resource management, food production and distribution, and population growth. Many other examples of new technologies or of new side effects of technology could be spelled out; for example, the international implications of information-processing developments, of genetic engineering, and, of course, of military technology. But the main points are clear; the functional demands that will result are different only in detail from those presented above.

Stanley Hoffman has observed succinctly, "The vessel of sovereignty is leaking." The presumed license for independent nations to do as they please is an abstract concept, when thought of in anything like absolute terms. Even in more modest relative terms, many of today's technological developments make it only a partial truth at best. Self-interest in the use of many technologies makes it mandatory for nations to reach agreements that constrain their freedom of action; to do otherwise would deny the use of the technology, or bring about various forms of retaliation. Nations continue to try to act as though they were sole masters of their fate, but the reality is far different.

What is striking is how far this process of erosion of sovereignty has already gone. Essentially all of the functions that I have deduced as being necessary by the 1980s' already have their counterparts today. Some are rudimentary and de facto, but others, even in the politically difficult regulatory area, are surprisingly extensive and effective. However, the general performance of international machinery today, notwithstanding its effectiveness in some areas, leads to considerable skepticism as to whether it provides an adequate base for expansion and for new responsibilities. The worst features of national bureaucracies pale into tolerability when compared with those of the international bureaucracies extant today.

Meanwhile, the growing constraints on freedom of national action, and the increased responsibility that will have to flow to multinational organizations, whatever their structure, will mean that the locus of decision making will steadily be forced from the national to the international arena. Nations will not necessarily lose their voice in the control of specific issues, but more and more issues will have to be settled in an international environment because they have in fact become international issues. Progressively, we exchange full control of our own affairs for a share in the control of the world's.

This trend will be accentuated if there also develops at the international level a new kind of interest-group politics. The activities of international organizations will increasingly impinge upon matters that are today of concern to national interest groups. It seems quite likely that there will be a tendency for interest groups to coalesce across national borders and to attempt to influence those international organizations that affect their fields of activity.

A countervailing trend, however, will be that the technological subjects discussed here—which have mostly been of relatively marginal interest to governments, hitherto—will be forced by their implications closer to the center of the political stage. Inevitably, this will imply greater national sensitivity to any loss of control, and thus increased resistance to any "delegation of responsibility" to international bodies.

But governments will have increasing difficulty in maintaining control of the process. We are talking here of issues that are so pervasive in society, that cut across so many of the direct concerns of individuals and in-

terest groups, that it is hard to believe that governments will ever be able to speak with a single voice in these matters. In fact, the difficulty of integrating policy at the national level (often cited in connection with the troubles of international organizations) will in fact become even greater than it is today. In the technologically related societal issues with which we are concerned, nations today speak with a plurality of voices. This situation is likely to be intensified rather than moderated. Given the difficulty of harmonizing the views of more than 120 such governments, it may be that we must look to the international level rather than primarily to the national level, to provide the necessary integration. If so, this would be another way in which the focus of decision making is likely to move toward the international scene.

These observations have yet another implication: that international organizations, of whatever form (universal, regional, or just bilateral), are likely to become more important elements in the international system. Today, notwithstanding all the attention, time, and effort devoted to them, or expended by them, they still are of secondary importance. Governments devote their attention to issues largely according to the political significance of those issues. International organizations, except for the highly political organization of the Security Council or of military alliances such as NATO, have counted for little in the political scale. This will change as the roles and functions of international organizations lead them to touch more directly on matters of sovereignty and economic benefit. Thus, nations will have to devote more attention to their policies toward the organizations, and to what the organizations do, how their secretariats act, and what happens in their executive organs.

The nature of the issues emerging from advancing technology and its side effects is such as to emphasize the connectedness of things. Increasingly, issues cannot be neatly divided into boxes labelled "oceans," "agriculture," "health," and so forth. This is no less true domestically than internationally, and again raises the problem of integration of policy and activity. In the future, this interconnectedness will make current problems of international jurisdiction and coordination appear relatively simple.

Another problem that complicates the issue of policy integration is the complexity and size of modern technological and organizational systems. This makes the task of innovation exceedingly difficult. The problems of innovation in existing international organizations and their activities are well known today. They can only be more difficult tomorrow.

In a different vein, we can point to what may be the hopeful beginning of increased public interest, in some countries, in the substantive issues that have been raised in this analysis, particularly environmental control and pollution. It will surely take such public interest, expressed in political activity, to bring about the kind of controls on man and his works, whether national or international, that will be required for survival.

Accompanying this increased public interest in the protection of man's environment there seems to be, though much less clearly, a growing recognition that governments do not have the right to act unilaterally in technological areas when the effects may spread beyond national borders. It remains to be seen how this recognition will develop, but it would be a prerequisite for any substantial movement by governments in the direction of relying more heavily on international organizations in their own decision making.

There is also, at least in the United States, a disturbing reaction to technology itself, a reaction which could take on dangerous "Luddite" aspects. To the extent that the solutions to technology-caused problems may lie in technology itself, this feeling could seriously inhibit progress toward protecting the generations to come. It may manifest itself first in pressure to keep down budgets for science and technology, and to exercise tight control in those very areas that are essential for understanding and ameliorating the physical and social problems the world faces.

The political environment in which international organizations will have to function will also change. Political developments between the two superpowers (or most likely three by the 1980's) will obviously have a profound influence on the evolution of international machinery. (China must be a part of the resolution of these technologically related issues, if for no other reason than that some of them cannot be dealt with adequately without her.) Developments in the nuclear arms race and in general political tension will substantially affect the possibility of facing up to the tasks I have raised here. One can further anticipate major conflicts of interest becoming serious sources of tension between North and South.

But, whatever the political developments of the next two decades, technologically related developments that are in some sense "inevitable" will pose major new international requirements. What the preferred course of evolution of the international system should be to meet these new requirements must depend, in part, on an evaluation of existing international machinery. Clearly, as a minimum, a substantial amount of extremely difficult institution building and institution modification will be required internationally. Whether such "evolution" will be enough, or whether we will need a "revolution" in the existing international order, is a controversial judgment, as is the question of whether governments and organizations will, in fact, recognize the extent of the problem in time for even moderate change in the system. Clearly the need for understanding the issues in detail is urgent.

Professor Skolnikoff's concern with the implications of science and technology for international affairs dates from his service on the staffs of three Presidential Science Advisers in the White House between 1958 and 1963. Starting as an electrical engineering graduate of M.I.T. (Class of 1949), Professor Skolnikoff continued in economics and politics as a Rhodes Scholar at Oxford, then returned to the classroom for a Ph.D. in political science from M.I.T. in 1965. He is the founder and Chairman of the Science and Public Policy Studies Group.

Nothing says "New England" like a covered bridge—but in fact there are more such bridges surviving in both Pennsylvania and Ohio than in all the New England states. This bridge is, nevertheless, in West Rutland, Vt., and careful readers of Mr. Wilson's article and observers of this picture will easily identify its structure. (Photo: A. Devaney, Inc.)

Anticipating readers' summer vacations, an ardent "covered bridger" provides an engineer's guide to the different structural forms which can be seen in the 990 remaining "bridges to America's past"

Raymond E. Wilson

Twenty Different Ways to Build a Covered Bridge

Though covered bridges form a colorful link to America's past, readers of *Technology Review* may be surprised to learn that this structural form is neither unique to the New World nor original in it. Indeed, Marco Polo recorded Chinese bridges "with very handsome roofs" in journals of his travels 800 years ago; and there are 230 covered bridges still in use in Austria, Switzerland, and Germany. The oldest in Europe, and probably in the world, is the Chapel Bridge in Lucerne, a footbridge built in 1333.

Most European covered bridges are of the timber trestle type, using short spans set on stone piers or wooden supports. A few of the older and larger Swiss bridges use massive arches with heavy radial struts and braces. The truss—though a sixteenth-century Italian invention—was not used in Europe until after it became common in America.

The basic form of the truss is the triangle, the only geometrical figure that cannot be distorted under load. All truss bridges, therefore, are designed with a single triangle or a series of adjoining ones. Andrea Palladio, an Italian architect, became a leader in the design of trusses and in 1570 published a book in which he showed four types—a queenpost design, a multiple kingpost truss, and two panel trusses with arched chords and X-diagonals. Palladio actually built one or more bridges incorporating such truss designs, and his treatise was published in English in 1742. But he was far ahead of his time, and his work was subsequently neglected by European builders, who favored the stone arch.

Only 200 years later, when bridge builders were confronted with the urgent problem of spanning large rivers of the North American continent surrounded by plentiful timber, was the truss rediscovered, and Palladio's sketches were undoubtedly studied by the American carpenters of the eighteenth and nineteenth centuries, who were skilled in the building of large barns and farmhouses.

Preserving the Structure

The first bridge of any appreciable length in the United States was a braced arch structure built by Enoch Hale in 1785 across the Connecticut River at Bellows Falls, Vt. Many New England carpenters thereafter experimented with bridge construction and developed a braced arch design, of which a number were built over the larger rivers. Finally, in 1805, the first covered bridge was built by Timothy Palmer, "bridge builder extraordinary" of New England. This was a three-span, 550-ft. structure using an arch truss with an arched roadway over the Schuylkill River on Market Street, Philadelphia. It is recorded that the bridge committee insisted that the heavy timbers be covered with a roof and siding as protection against the weather—the sole purpose, incidentally, of the bridge enclosures. The life expectancy of an open bridge was seldom over 10 to 15 years due to rotting of the timbers, while covered bridges have been maintained over 100 years.

After completing the Permanent Bridge in Philadelphia, Palmer built but one other structure—crossing the Delaware River in Easton, Pa.—before retiring. However, the point had been made, the young country was developing rapidly, and there was tremendous demand for covered bridges to span the many large rivers along the Atlantic coast. Louis Wernwag, a German immigrant with demonstrated skill as mechanic and bridge builder, realized the situation and in 1812 secured the contract to build the Colossus Bridge, a 340-ft. structure across the Schuylkill, which he designed and successfully completed as an arch truss. His reputation established, he erected some 30 other large covered structures between 1810 and 1838, using heavy arches with flared multiple kingpost trusses on either side. None of these bridges now remains, although the occasional use of flared posts in other types of designs causes some confusion as to their proper designation.

Theodore Burr, the third and greatest member of the pioneer group of covered-bridge builders, was born in Connecticut in 1771, moved to New York to become a skilled carpenter-mechanic and operate his own saw mill, and finally located in Harrisburg, Pa. He, too, had adopted Palladio and designed a large bridge using a multiple kingpost truss, the first to depend upon a truss without an arch. But he found quickly enough that such a bridge was not stable under live loads, and he was forced to strengthen it with arches. On this basis he continued to build large bridges throughout the Northeast—including a successful 400-ft. span across the Hudson River at Waterford, N.Y., in 1804 using an X-panel truss and two arches; this bridge—probably the first arch bridge to have a level roadway—was not covered until 1814.

A Glossary of Terms Applying to Covered Bridge Trusses

Brace: A diagonal timber which slants upward toward the center of the bridge.

Chord: The horizontal timber or timbers forming part of the truss; a lower chord supports the floor, an upper chord the roof.

Counterbrace: A diagonal timber or rod which slants upward away from the center of the bridge.

Deck: The floor or roadbed of the bridge.

Diagonal: A timber or rod which slants, usually between two panel posts.

Flared post: A post with the top slanting toward the end of the bridge.

Footpiece: A specially designed casting, usually placed between diagonals and chords for rigid assembly of members.

Laminated arch: A series of planks bolted together with staggered joints to form an arch; used in lieu of a solid timber.

Panel: That portion of a truss included between two vertical posts.

Post: A vertical or upright timber in a truss.

Span or clear span: The length of a bridge between abutments or piers. A truss span is the length between the end posts of the truss.

Truss: An arrangement of timbers and rods to support each other—as well as other loads—rigidly. This requires the use of a suitable combination of triangles.

It was in 1817 that Burr patented his revised arch-truss design using a multiple kingpost truss which soon became the most popular covered bridge structural system. Unfortunately, he soon thereafter extended his activities too far, accepting contracts for five huge structures over the Susquehanna River at once. He failed financially, and this was undoubtedly a factor contributing to his early death in 1822.

These are among the highlights in the early history of a romantic chapter in American engineering which has now attracted a company of dedicated hobbyists. It has been estimated that over 10,000 covered bridges were built in the U.S. between 1805 and 1885. All of the truly massive old structures—ranging in length from 500 ft. to the record 5,690 ft. in Columbia, Pa.—have long since been replaced by steel or concrete bridges. But in 1955, 1,564 covered bridges remained; by 1970 the count was down to 990. The longest still standing is 468 ft. long, over the Connecticut River at Windsor, Vt., of Town truss design, built in 1866. The oldest, near Lewisburg, Pa., of Burr truss design, was built in 1812. Canada has over 400 covered bridges, mostly in Quebec and New Brunswick and mostly of Town and Howe truss design, respectively; only a few of these were built before 1900, and they, too, are rapidly disappearing. The longest is in Hartland, N.B.—1,282 ft.—and there are four others which measure over 500 ft.

"Kissing Bridges"—and Other Uses

The most common reason for the loss of covered bridges today is local apathy, with resulting lack of maintenance and collapse. Floods and windstorms continue to exact a toll, but in recent years arson has become a more serious problem; some 70 covered bridges have been so destroyed in the past ten years. Careless truck drivers with too-heavy loads at excessive speeds are responsible for losses, and the increasing number of very large reservoirs for flood control and recreation have contributed to the toll.

Covered bridges once played a vital—and unique—part in the life of nearby communities. Their importance as communication links was fundamental, and is obvious. But the bridges were often the largest covered areas available to the communities, and so they were used for political rallies, revival meetings, and even for weddings. Many a courtship was fostered in these "kissing bridges"—to the delight of youngsters hidden in the rafters. They served as welcome shelters in sudden storms and as protected sites for robberies and murders. The inside walls and timbers were used for communications, carrying advertisements of local stores, circuses, patent medicines for man and beast, and even religious mottos; some of these—as well as many carved initials and hearts—are still legible.

During the past 11 years this writer has visited nearly all of the covered bridges in the United States, about one-third of those in Canada, and a number in Europe. When we first became interested in this hobby, the features which impressed us most were the huge arches with the heavy timber trusses between, which are the marks of the Burr truss. We soon discovered 75 of these bridges within 100 miles of Swarthmore, Pa., where we live. With an engineering background, we quickly became fascinated in studying the construction details and marvelled at the superb hand workmanship of the builders in hewing and assembling the heavy timbers.

As the range of our "bridging" travel was extended to New England, the South, and the Midwest—particularly to Ohio and Indiana—we found covered bridges of many types. Eventually we have come to identify 21 different structural forms, not including variations. Except for information published in two books by Richard S. Allen, we were forced to gain our knowledge of many of these structural variations and their modifications the hard way.

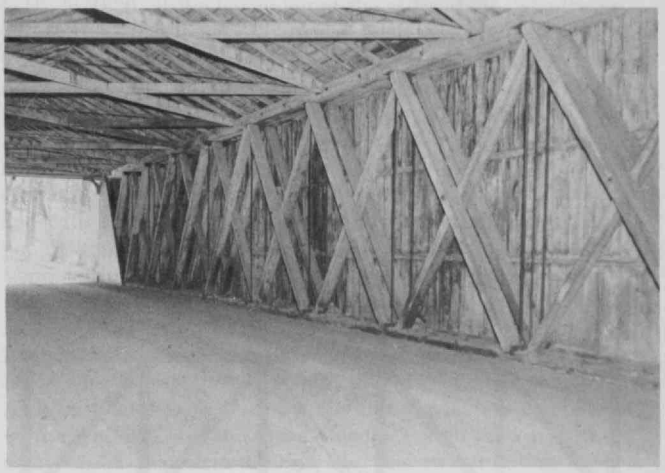
Having accumulated such data, we can now list below the different types of trusses and arches which may be found in the 990 existing U.S. covered bridges—and one in Canada. Readers inspired by this list to seek and study covered bridges during their summer vacations will find that their quest carries them off the speedways to quiet country roads and small villages, that it opens up new friendships, and that it is a uniquely rewarding way to enjoy an auto trip. Perhaps they will become—like the author—"covered bridgers."

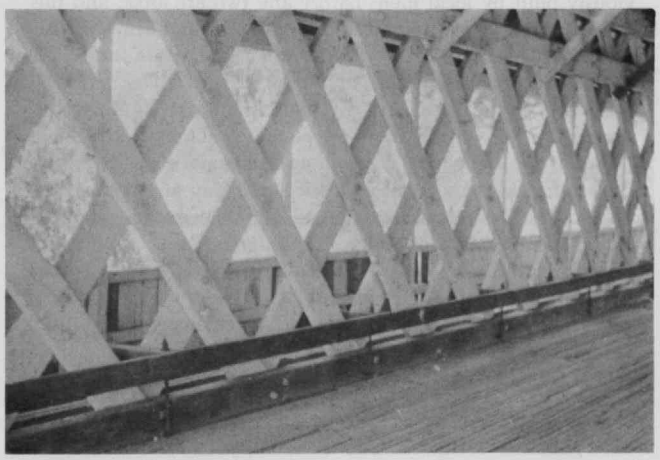
Suggested Reference:

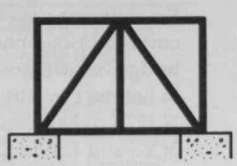
World Guide to Covered Bridges. South Peabody, Mass.: National Society for the Preservation of Covered Bridges, Inc. ($2.50).

Raymond E. Wilson graduated in mechanical engineering from M.I.T. in 1912, and for most of his career thereafter he held engineering and management assignments with the Associated Factory Mutual Fire Insurance Co. in Providence, Boston, Philadelphia, and Washington. He has made Swarthmore, Pa., the headquarters for his covered bridge excursions throughout the North American continent since his retirement in 1963.

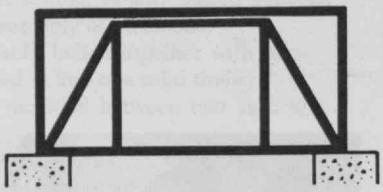
Six different structural forms are included in this group of covered bridge photographs from the author's collection. The bridges shown are—or, in some cases, were—(left column, top to bottom) in Rifton, N.Y.; Germantown, Ohio; Winchester, N.H.; (right column, top to bottom) Downsville, N.Y.; Troy, N.Y.; and Union County, Ohio. (Photos: Raymond E. Wilson and Richard Wilson)



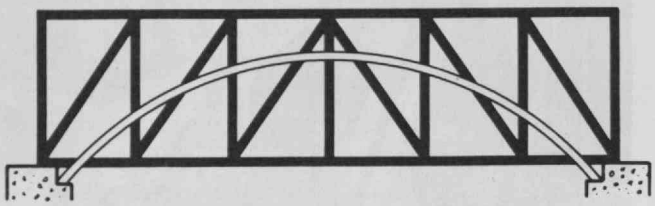




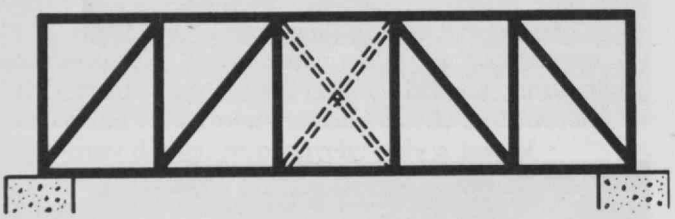
1. The Kingpost Truss. The kingpost is the oldest and simplest truss, used in roof building for hundreds of years. It consists essentially of the basic truss triangle with two timbers slanting down from the center to the ends of the lower chord of the bridge. The kingpost extends down vertically from the center to the lower chord, forming two combined triangles. This post is a tension member, with the diagonals and lower chord in compression. There are 53 covered bridges of this type in use, half of them in Pennsylvania. These bridges are seldom over 30 to 35 ft. long, but with the use of reinforcing timbers and rods—diagonal, horizontal or vertical—spans of over double this length have occasionally been noted.



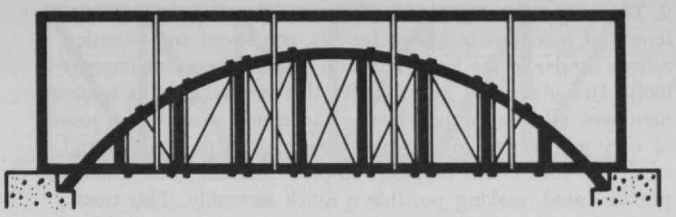
2. The Queenpost Truss. The queenpost can be used for longer spans but seldom for more than 60 to 70 ft., even when braced. There are still 103 queenpost bridges, mostly in Pennsylvania and Vermont. The truss is built as a truncated triangle with a post at each end and a connecting horizontal crosspiece which *must* be independent of the top chord of the bridge and is usually located directly under it. A variation is the pony queenpost, with its crosspiece perhaps only 5 to 10 ft. high. The truss is usually braced in the open, center section, using various arrangements of timbers and rods.



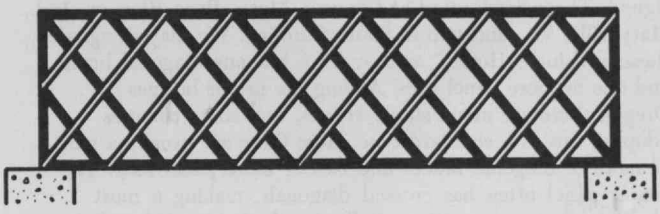
3. The Burr Truss. The Burr Arch Truss is commonly used for longer spans, 100 ft. or more, although a few are but 50 ft. in length. There are nearly 300 still standing, of which 175 are located in Pennsylvania, 70 in Indiana, 15 in Ohio, and 17 in New England. The truss is of the multiple kingpost type with panel posts generally spaced 10 ft. apart. Between each panel post there is a diagonal timber brace, sloping up toward the center of the bridge. A heavy timber arch is fastened to each side of the truss; for the longer bridges there are double arches. The arches vary in height from about 4 ft. to perhaps 12 ft., or to the top chord. The posts are normally vertical but are sometimes flared slightly with tops slanted towards the end of the bridge; in a few bridges the posts are set nearly at right angles to the arch. Often, as in Lancaster County, Pa., vertical suspension rods, running down from the arch to the lower chord and equipped with screw ends, nuts, washers, and blocks, have been installed in each panel. With this arrangement an appreciable part of the live load is transferred from the truss to the arches. In the older bridges, arches are usually of heavy hewn timbers, but laminated arch construction—up to 12-ply, generally of 2-in. planks nailed together with staggered joints—is found in the newer structures. Some of the first trusses built by Burr had a diagonal-X panel, but only one or two can now be found and these are not too old.



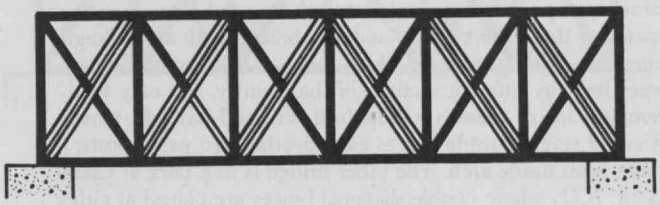
4. The Multiple Kingpost Truss. This is the truss used in the Burr Truss and described above. There are 101 bridges with this type of truss, 82 of which are in Ohio; most of the latter are 50 to 100 ft. long. There are many modifications, variations, and reinforcements of the basic design. The bridges were obviously built by local men; hardly any two are alike, and this fact makes possible an interesting study, found only in Ohio. One unique feature is the open center panel, often found when there is an odd number of panels. An X center panel is occasionally found in others. Another unique structure is the skew bridge, set at an angle to reduce or eliminate the angle of entrance; horizontal, vertical, and diagonal tie rods are used for reinforcement as well as a special U-guy arrangement. Others have the braces reinforced with half-counterbraces. There are a number of composite designs, some combined with rod counterbracing, like a Childs Truss (*see below*), others with outside and inside guy rods, and others with some Long Truss X-panels (*see below*). Seven bridges have single inside arches and queenposts. There are three bridges which have cambered or curved flooring. The bridges in other states are of orthodox design.



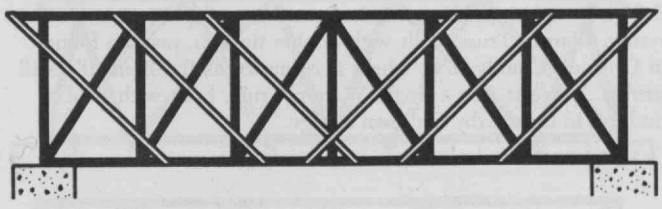
5. The Arch. The wooden arch has occasionally been used in lieu of a truss, usually tied at the ends to the lower chord of the bridge. The live load is carried by iron suspension rods running from the arch to the lower chord, using blocks, washers, and nuts for adjustment. Vertical timbers are placed close to each of the suspension rods, and there may be auxiliary diagonal suspension rods. There are seven examples of this type—four in Vermont (one in East Charlotte, two near Brownsville, and the Lincoln Bridge in Woodstock). The vertical suspension rods in the Lincoln Bridge are supplemented by a system of crossed diagonals not unlike a Pratt design. There are two crudely built covered bridges in Newport, Va., with straight timbers set to form an arch between the panel points and many small wooden posts between panels, as well as suspension rods. The seventh bridge, in East Minford, Sciota County, Ohio, has two diagonal timbers instead of an arch but with vertical suspension rods to carry the load.



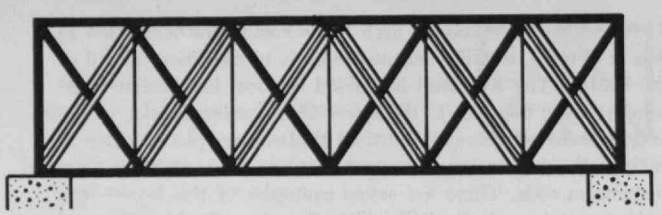
6. The Town Truss. The Town Truss was designed and patented in 1820 by Ithiel Town, a New Haven architect, who realized the need for a covered bridge truss which could be quickly built by any good carpenter. His bridge was the first truly American design and consisted of a web of light planks criss-crossed at an angle of 45° to 60° like a lattice and fastened together with wooden pins or trunnels at each intersection. It was light and cheap and could be assembled in a few days' time. The design was well received, and—thanks to good advertising and many scattered agents—it soon became most popular both for highways and later for railroads, in which case it was more heavily built and reinforced with extra chords. Some 165 covered bridges of this type may still be located, some with an auxiliary inside arch, particularly in New England, Pennsylvania, Ohio, and the South.



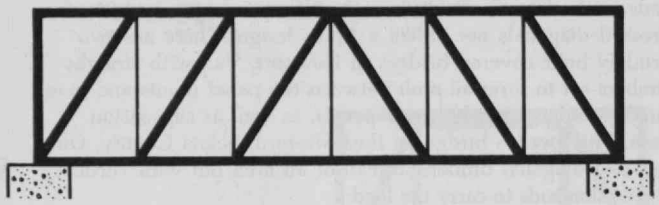
7. The Long Truss. The Long Truss was designed and patented by Colonel Stephen H. Long, an Army engineer of Hopkinton, N.H., in 1830, at the beginning of the railroad era. The truss was of the panel type with crossed single timbers between wooden posts. Long, like Town, was a promoter and competed successfully in selling his truss for highway and railroad use from Maine to the Deep South. The truss was essentially a multiple kingpost with counterbraces. Although the patent showed two single diagonals, practically all bridges now in use are built with two braces and one counterbrace in each panel, and with either one or two posts. The arrival and immediate popularity of the Howe Truss in 1840 affected the number of Long Trusses built, and there are today only 19 left, most of them well over 150 ft. in length. Among these is the well-known double-barrel Blenheim Bridge in New York and Rowell's Bridge in New Hampshire. Both have arches, and the latter has double-intersecting diagonals, the only example extant. Another interesting modified Long Truss which is combined with a Childs Truss and has an auxiliary arch is located at Odaville, W. Va. Oxford, Ohio, also has an interesting Long and Childs combination. There is a unique "home-made" design in Thomas Store, Ga.



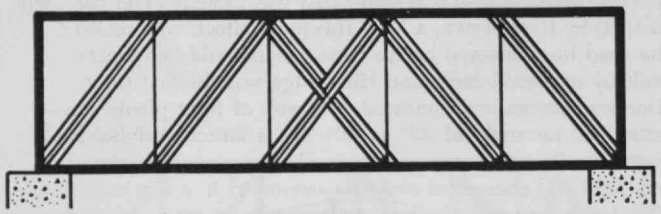
8. The Paddleford Truss. The unpatented Paddleford Truss is only found in New England, where there are 23 examples still standing, mostly in New Hampshire. The truss was designed by Peter Paddleford of Littleton, N.H., who had previously erected several fine Long Truss bridges. About 1846, he remodelled this design by replacing the counterbraces with a stiffening member fastened to the inside of the posts at points near the tops and bottoms and extending to the top and bottom chords. This resulted in an unusually strong and rigid structure. Other local builders became interested, and a considerable number were erected. Twelve of these have a heavy inside arch, probably making them the strongest of any existing type of truss.



Howe (usual)

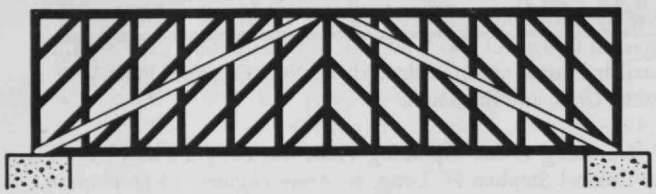


Howe (single)

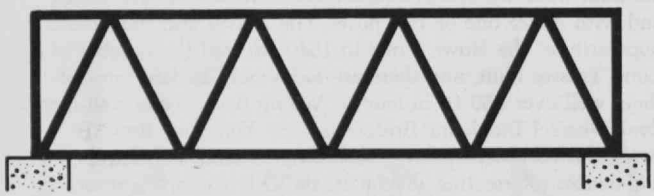


Howe (Western)

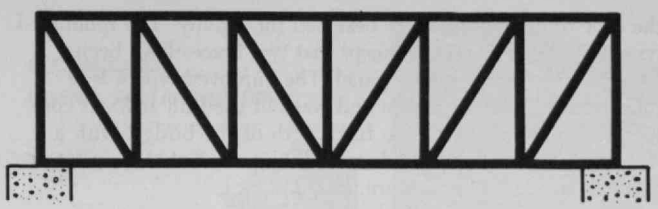
9. The Howe Truss. In 1840, William Howe, who came from a family of inventors in Massachusetts, conceived and patented a truss similar to the Long but with a most important improvement. He substituted iron rods for the wooden post as tension members, eliminating one heavy timber and providing a means of easy adjustment by having screw ends with washers and nuts. The rods could be easily shipped and the truss timbers prefabricated, making possible a quick assembly. This truss gradually replaced other trusses; in fact very few covered bridges other than the Howe were erected after 1880 and it was easily the most popular design during the last half of the century, in the East, Middle West and on the West Coast, where many new covered bridges appeared well into the 1900's. Like the Long Truss, the patents showed single timbers for posts and diagonals. Actually most bridges in the East and Midwest have two diagonal braces and one counterbrace in each panel and two vertical rods between, except that often the end panels have three rods. There are but five Eastern bridges not so designed. These are located at Conway, Mass., Bean Blossom, Ind., Marysville, Va., and two in South Carolina. We may designate these as "single Howe," as they have but one diagonal brace and one or more panel rods. Among the newer bridges of Oregon there are many single Howes, and some counties adopted this as a standard type. Here there are usually a pair or more of diagonal braces and two or more panel rods. The center panel often has crossed diagonals, making a most pleasing appearance with partially sheathed sides. Fifty of the 162 Howe bridges are in Oregon, 30 in Indiana, and 20 in Ohio.



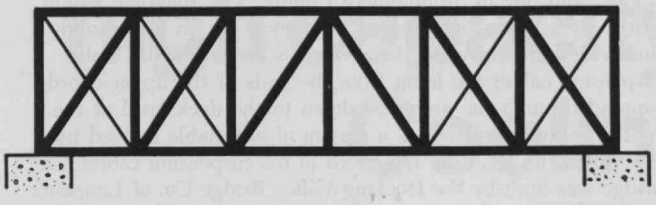
10. The Haupt Truss. The unusual Haupt Truss design was patented in 1839, and two modified examples are still standing. General Haupt, a Pennsylvanian, was a noted bridge engineer and designer who graduated from West Point and became Chief of Military Railroads during the Civil War. His patents show a panel-type truss using single-latticed diagonal braces, each spanning three short panels and also braced with a full-length kingpost, serving in place of an arch. A number of bridges were built in different sections of the country, but only two remain. One of these is in Thetford, Vt., and has 4-ft. panels. A set of single outside braces each overlap two panel posts; there is an inside arch. The other bridge is in a park at Claremont, N.C., where double diagonal braces are placed at either side of the posts to span only two 4-ft. panels. There is no arch.



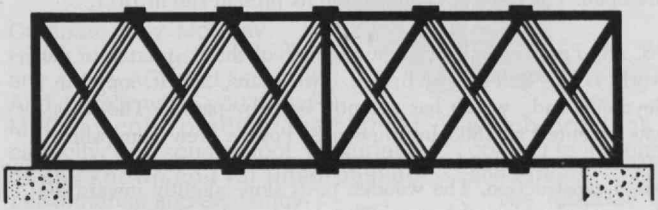
11. The Warren Truss. A simple light-weight truss was patented in 1838 by two Englishmen, James Warren and T. W. Morzani. It is a well-known steel bridge design, particularly for railroads, and is still so used both in England and the United States: it was used to some extent as a timber bridge in the Middle West and later on the West Coast, due to easy assembly and maintenance. The Warren Truss is built in both the single and double system types; the single type consists of a series of diagonal timbers placed in the form of a W with no rods or panel posts. The double system has a second similar set of diagonals which intersect the first. There are still three covered bridges of the single type in Ohio, two having arches added. One without arch is in Muskingum County, owned by the Southern Ohio Covered Bridge Association who use it for meetings and picnics. A double-system Warren Truss, built with double timbers, may be found in Greenup County, Ky., where it is known as the Bennett's Mill Bridge. There is also a single Warren Truss, built with double timbers, in the nearby Oldtown Bridge.



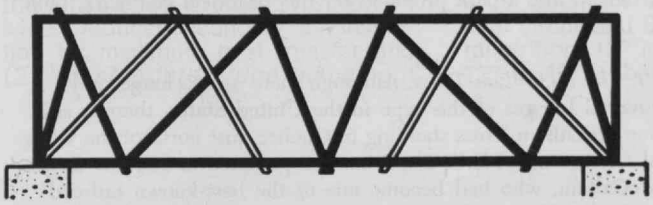
12. The Pratt Truss. The Pratt Truss was the invention of T. Willis Pratt of Boston, an architect and engineer specializing in railroading. He secured a patent in 1844 for a panel-type truss using wooden posts and crossed diagonal rods, just the reverse of the Howe Truss. As designed it proved difficult to adjust; so the "braces" which were tension members were removed leaving only the diagonals which sloped up towards the end of the bridge. As an all-steel truss it was adopted by railroad and highway engineers as a standard type which is still used throughout the country. There is such an all-steel truss in the covered bridge at Keener, Ala., with latticed posts and two-rod diagonals. There are also two examples of the revised wood and steel design in California at Honey Run and Felton.
The Teco Truss. The World Guide lists five covered bridges as having Teco Trusses, which we understand were designed by the Teco Engineering Co. of Washington, D.C. All are of prefabricated timber and are allegedly fitted with special metal connectors or footpieces at the chords for added rigidity. These bridges vary in age from 5 to 20 years. The oldest, in Greenfield, Mass., has a double-intersecting Long Truss with four diagonals and a single post in each panel. The three in Sheffield, Mass., Pepperell, Mass., and Champagne County, Ill., are of the Pratt type with heavy three-timbered diagonals and timber posts. The Bedford, N.H., motel footbridge has a single-timber Pratt-type truss. The County Bridge in Hancock, N.H., listed as "part steel," has inner sheathing, preventing inspection. This 80-ft. bridge was built by Hagen-Thibodeau, Wolfeboro, N.H., in 1937, and has a six-panel, all-timber Pratt Truss with double timber diagonals and chords and single posts, using Teco special split-ring connectors.



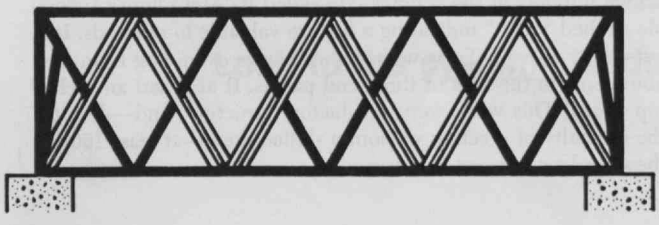
13. The Childs Truss. The Childs Truss was patented in 1846 by Horatio Childs of Henniker, N.H., one of three brothers who were subagents for the Long Truss and had for many years been building covered bridges of the Long design for railroads and highways in New Hampshire and adjoining states. The design is basically a Long Truss with counterbraces replaced with a tension rod, resulting in a lighter adjustable truss. Strangely, the design was not used in the East. However, Everett Sherman, a New Hampshire man who had moved to Ohio and was probably familiar with the patent, built a number of these structures in the 1880's. There are now seven of these in Preble County and one in Delaware County. They are still in fine condition, undoubtedly due to the maintenance care of Seth Schlotterback, County Engineer, who is a devoted bridge fan, recently retired.



14. The Brown Truss. The Brown Truss was patented in 1857 by Josiah Brown, Jr., of Buffalo, N.Y. It is a very light and simple design built of single intersecting diagonals set at 60°. Their ends are mortised and bolted together with the upper and lower chords to provide rigid joints. There is a center post but no end braces or vertical tension rods. It somewhat resembles a Howe Truss though it is easily distinguished by the lack of panel rods. This bridge truss may be found only in the three structures located in Kent and Ionia Counties, Michigan.



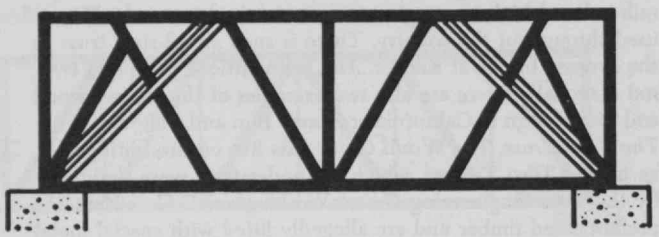
Smith



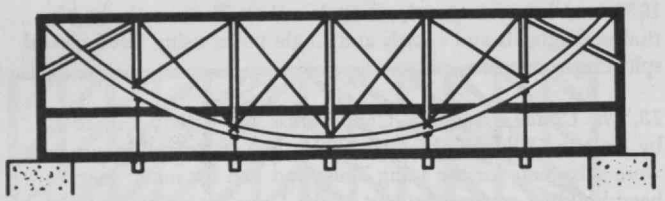
Improved Smith

15. The Smith Truss. The Smith Truss is a most interesting form of light but strong construction. It was designed by Robert J. Smith of Ohio, a successful inventor, builder, contractor, and promoter, who often provided prefabricated structures built at his mill in Tippecanoe City, which he later moved to Toledo. He patented his first truss in 1867 and a second in 1869, and he later developed—but did not patent—reinforced (type 3) and further improved (type 4) versions. The 1867 type was probably never used. There are 27 covered bridges of the three other designs located in Ohio, Indiana, and (one each) Mercer County, Pa., and Santa Cruz, Calif. Type 2 is built of single timber diagonals with counterbraces set at 60° and bolted to the upper and lower chords. The intersecting braces, set at 45°, are arranged with ends against the counterbraces. The center panel has an open V. The end diagonals are braced and

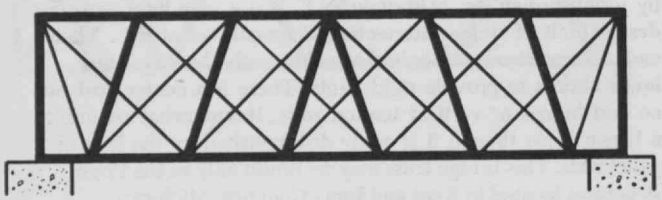
the roof framing is specially designed for rigidity. The reinforced type 3 is similar to type 2 except that two braces have been added to the open-V center panel. The improved type 4 is of substantially different design and was not used till 1875. It consists of double diagonals the full length of the bridge, with a second set of single diagonals intersecting the first. All are set at 60°, and the end diagonals are braced.



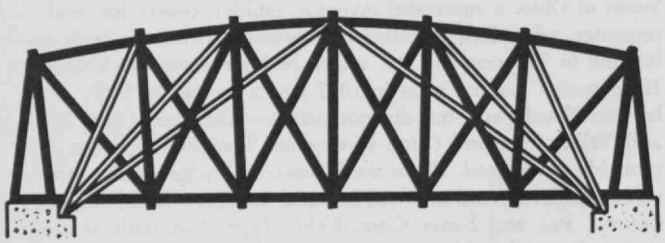
16. The Partridge Truss. In 1855, Reuben L. Partridge, a carpenter of Marysville, Ohio, designed and patented his first covered bridge which he termed "self-supporting." It became successful, and it is claimed that he built over 100 in Union County before 1872, when he obtained a patent on his "high truss" improvement and continued his successful career. The design is remarkably similar to that of Robert Smith, showing a series of single intersecting diagonals with 60° counterbraces bolted to the chords and with 45° braces between as shown in the Smith design. A special "bifurcated shoe" or metal footpiece is added to fasten the ends of the braces at the chords, and there were also included braces for the end diagonals. There are presently five of these bridges of a much modified type in Union County and one in Franklin County. None follows the patent design closely, and no two are alike. One to three timbers are used for braces and one or two for counterbraces. Most have been reinforced liberally with diagonal and vertical rods. All are striking in appearance and well maintained.



17. The Bowstring. Ohio, with its many types of covered bridges, provides a real treat for covered bridge fans with two examples of a bowstring suspension-arch covered bridge, one in Lancaster County and one in Montgomery County. The Jonathan Bright Bridge, 2½ miles southwest of Baltimore, has an 80-ft. solid-timber tied arch to which the five posts are fastened. Double suspension cables are hung from the ends of the upper chord, running through the arch and down to the deck level at the center. In addition there is a system of adjustable crossed iron ties which run from the top chord to the suspension cables. The bridge was built by the Hocking Valley Bridge Co. of Lancaster in 1881. Nearby there is an open iron bridge of similar construction except for the arch. The second covered bridge, built in 1870 in Germantown, Ohio, is 103 ft. long. Bowstrings or flat iron suspension members are swung to the floor level from each end of the upper chord with crossed tie rods, also running down to the bowstring in each panel. There are special U-shaped stirrups from the bowstring to the deck beams. The sides of the bridge are open. The bridge was moved to its present site in 1911.

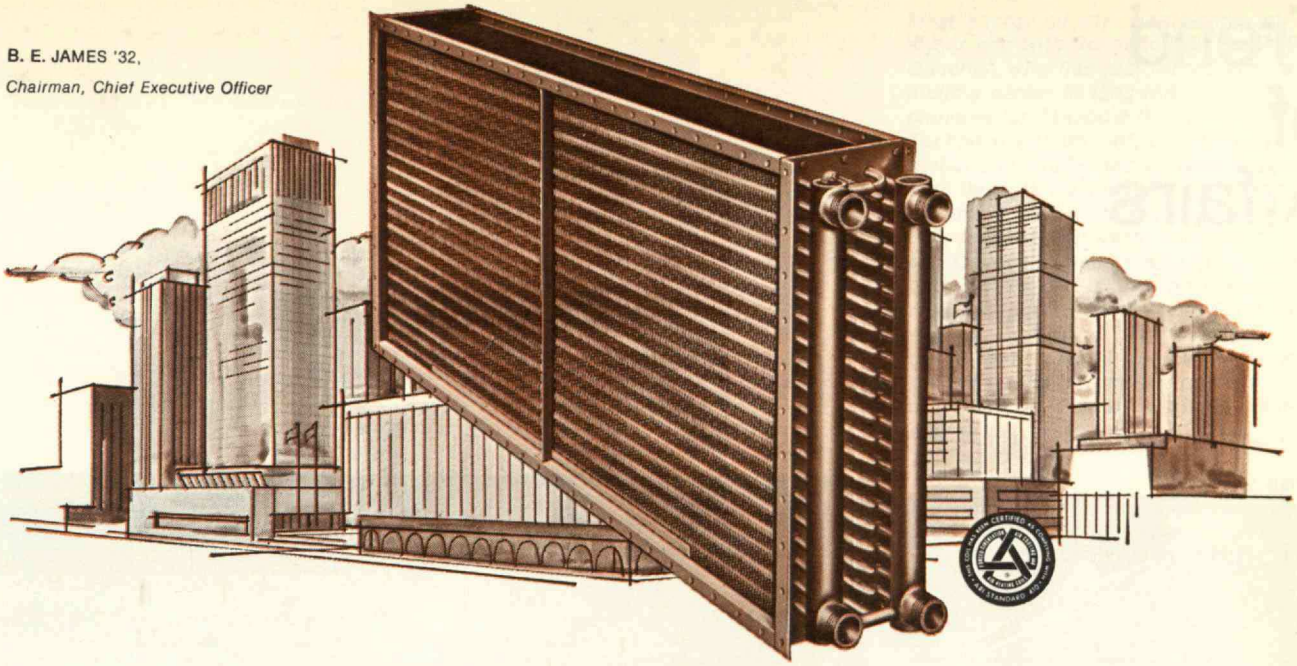


18. The Post Truss. The single example of the Post Truss in the world is the Bell's Ford Bridge (two spans, 325 ft. long) in Seymour, Ind., which has recently been by-passed. The truss was patented in 1863 by Simeon S. Post, a New Hampshire inventor and railroad engineer. It is of most unusual design, of panel construction. The wooden posts slope slightly inward and there are double-rod braces. The double-rod counterbraces span two panels. It is hoped that local maintenance will be arranged and a park provided for this historical landmark, built in 1869.



19. The McCallum Truss. Although there are no longer any covered bridges of this type in the United States, there is still one McCallum Truss standing in Quebec, just north of the village of Chateauguay, N.Y. The truss was patented in 1851 by D. J. McCallum, who had become one of the best-known railroad bridge builders in the country. He called it "McCallum's Inflexible Arched Truss," indicating a feature valuable to railroads. It is essentially a Long Truss with timber braces extending from the abutments to the tops of three end panels. It also had an arched top chord. This was a very satisfactory structure, and—despite the difficulty of erection without a skilled crew—at least 150 of these bridges were once in use.

B. E. JAMES '32,
Chairman, Chief Executive Officer



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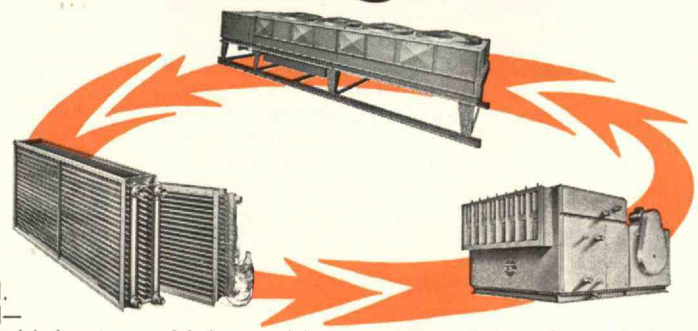

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The difference is McQuay's fusion of two advance design features: (1) the turbulence-creating *rippled fin* which reduces boundary air insulation for maximum heat transfer and (2) the *staggered tube* placement which provides maximum tube-air contact to increase heat transfer rates still further.

The McQuay line of cooling coils, both water cooling or evaporator, offers unsurpassed flexibility with a wide variety of standard fin spacing and circuiting. Standard fin lengths range from 12″ to 120″, heights from 12″ to 42″ — both in 3″ increments.

There are standard coil depths of 3, 4, 5, 6, 8 and 10 rows. All McQuay water cooling coils have vents and drains. Both water cooling and evaporator coils are counterflow circuited for maximum performance.

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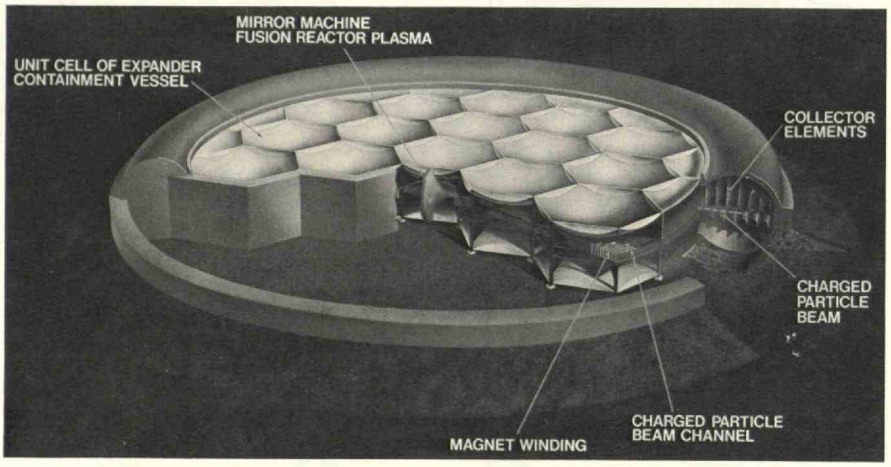
Trend of Affairs

POWER SOURCES

Fusion Power from a Decelerator?

Assuming that controlled nuclear fusion reactions are achieved, there is still the question of how to extract useful electric power from an ionized gas at a temperature of several million degrees. One solution, for certain kinds of fusion reaction, is being explored at the Lawrence Radiation Laboratory. It involves giving the reactor a very wide berth indeed.

The output from the reactor consists of whatever escapes the magnetic "bottle" in which the reacting plasma is contained. For some reactions, such as deuterium-helium ($D\text{-}He^3$), this would be a dense stream of high-energy protons, plus some charged particles (D and He^3) at a range of lower energies—around 500 keV.—plus a smaller flux of 2.5 MeV. neutrons. Another reaction, deuterium and tritium, would produce a stream of high-energy helium plus charged particles around 500 keV.—plus a flux of 14.7 MeV. neutrons. One way of transforming the charged-particle output into a useful current would be to separate the positive particles from the electrons.



Direct-conversion nuclear fusion power plant envisaged at Lawrence Radiation Laboratory features a vacuum chamber some 160 m. across, whose object is to reduce space-charge effects in the particle beam leaving the central fusion reactor. Around the rim of the chamber is a decelerating electric field, to convert the kinetic energy of each particle into potential energy, and a series of collectors at different voltages corresponding to the range of energies of the particles. (Courtesy Lawrence Radiation Laboratory)

If a fast-moving proton is simply caught on an electrode, its kinetic energy is dissipated as heat. To harness the energy of such a particle, it is first necessary to slow it down. This means that, for example, a 500-keV. proton must be caught on an electrode which is at 500,000 V. with respect to the source—and so on for the other energies.

For slowing down the particles, thought Richard F. Post of Lawrence a couple of years ago, one needs something like a particle-accelerator, only operated in reverse. And for catching the particles and turning them into a current, one needs a whole series of electrodes arranged along the backward-accelerator at different voltages.

But first, there is one difficulty. The particles emerging from the plasma machine are so crowded together that space-charge effects make them hard to steer. To give them room to reach a manageable density, the Lawrence researchers envisage a vacuum chamber, with a magnetic field for guidance, about 100 meters in radius. Holding up the roof of this evacuated ballpark against the thrust of atmospheric pressure outside will be a considerable engineering job, and is a large component in the cost of the envisaged machine—it might cost $20/kW.

Dr. Ralph W. Moir, who went to Lawrence from M.I.T., recently brought the Institute's nuclear engineers up to date on this project. Laboratory and computer-simulation work have been progressing rapidly for about a year. A low-energy reverse-accelerator device which Dr. Moir and his coworker Dr. Barr have built has shown an efficiency of 74 per cent in the conversion of a particle-beam to a current. This eleven-electrode system is realistic in that it handles a wide range of particle energies (100-300 eV.), bringing most of the particles to a halt at their appropriate electrodes.

Computer simulations indicate that efficiencies in the region of 90 per cent should be possible. Energy losses are mainly due to particles hitting the wrong electrode at high speed, and are thus in the form of heat. Dr. Moir notes that a real fusion-plasma converter, out at the edge of the "vacuum-park," would work at quite low power densities (about 300 W./sq.cm.), so cooling of electrodes would not be troublesome. The materials problems that have hampered the practical application of M.H.D. should not arise.

Most energy supply-and-demand analyses end with the year 2000. Leon P. Gaucher, who has just retired after a lifetime career in long-range scientific planning for Texaco's Research and Technical Department, carries his predictions to 2200—and thereby hangs a tale. By then, he says, energy will be expensive enough to discourage further U.S. population growth. Even so, Mr. Gaucher's energy-source vs. energy-demand diagram shows an energy need—beginning in the year 2000 and growing by 2200 to more than half our present energy consumption—which cannot be filled from any present sources. The answer? Perhaps solar energy.

A 30-Year Cycle of Energy Development

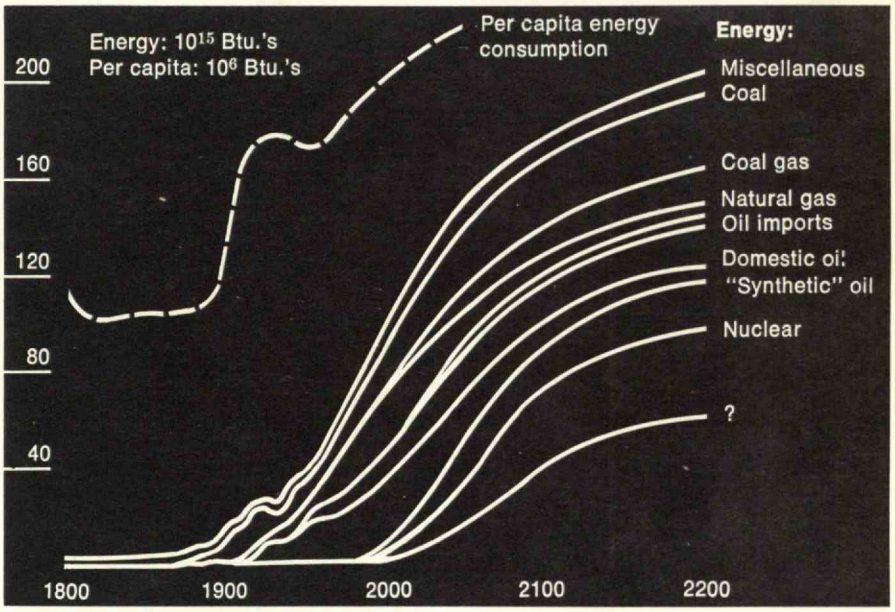
After more than 40 years in the energy business (with Texaco) since he graduated from M.I.T., Leon P. Gaucher thinks he sees the end of the rainbow. From now to—and somewhat beyond—the year 2000, the combination of growing per capita energy consumption and growing population will yield "a fantastic increase in energy requirement." But in the 200 years thereafter, Mr. Gaucher proposes that U.S. population growth may nearly have ended, per capita energy consumption have leveled off, and solar heat have become a principal energy source.

The argument that such stability represents our "ultimate destiny" is based on the predicted growing scarcity of fossil fuels and growing cost of pollution abatement. These will so affect the standard and cost of living, predicts Mr. Gaucher, that parents will finally accept the necessity of family planning to provide their children with proper care and education.

Mr. Gaucher proposes these trends in an article in the American Chemical Society's new magazine *Chemtech (March, 1971, pp. 153-158).* Here are some details:

Petroleum is by far the largest single source of energy in the world today, and our dependence on it is compounded by the fact that it is also the basic raw material for almost all of our organic chemicals—surface coatings, plastics, synthetic rubber, and a host of other products. Even a brief shortage of oil would have "a crippling effect" on the economy.

Such a shortage of natural crude—and especially natural gas—will develop gradually after the year 2000, and the result will be a growing market for "synthetic" liquid fuels made from coal. Hence Mr. Gaucher's prediction that by the year 2000 the use of high-Btu. gas from coal will be greater than today's consumption of natural gas—which is at the rate of 2 billion cu. ft. per hour.



By 2200, says Mr. Gaucher, half of our energy will be supplied in the form of electricity and the greatest bulk of that will be from nuclear generation—a total of 10 trillion kWh. To realize that assumption, breeder reactors will have to be successful by 1990; otherwise, there simply won't be enough uranium.

Even so, Mr. Gaucher's projections of needs and resources leave an energy deficiency gap which by the year 2200 is half of today's total energy consumption. But don't start hoarding coal and oil—yet. Mr. Gaucher's analysis notes "the regularity with which new sources of energy have been developed" at roughly 30-year intervals—coal before 1850, gaseous fuels in the 1870's, liquid fuels in 1900, then hydroelectric and nuclear power.

What will come 30 years after fission? Mr. Gaucher's guess is solar energy. Indeed, he writes, "if man's ingenuity had been directed to the utilization of solar energy instead of to the development of devices to consume fossil fuels, it is conceivable that we now would have a solar economy that is just as effective and efficient as our present fossil fuel economy."

WASTE CONTROL

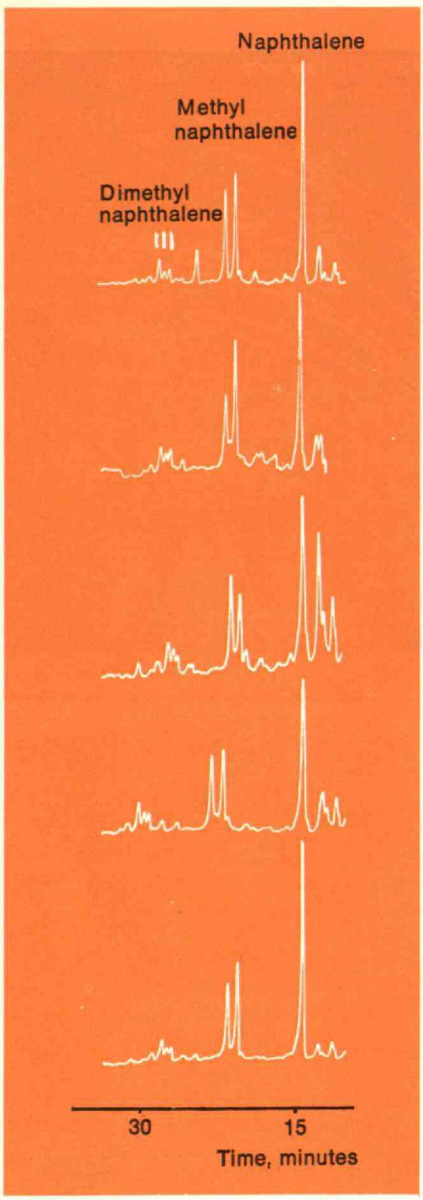
Urban Vehicle Race

The 1970 Clean Air Car Race (*see* Technology Review *for January, pp. 20-29*) will have a new run—with a difference—next year. An intercollegiate committee with headquarters at M.I.T. is now planning a competition in the summer of 1972 to encourage student development of automobiles specifically built for city driving.

Rules for the Urban Vehicle Design Competition will encourage cars designed primarily for city use which are low- or non-polluters and which at the same time have desirable safety, size, and noise characteristics. There will be no coast-to-coast race as in 1970; instead, there will be urban tests in which entries compete under real urban driving conditions. The criteria of success will include pollutant emissions, performance, noise, safety, reliability, space efficiency within the vehicle, and fuel efficiency.

A complete set of preliminary rules, specifying limits on vehicle size, passenger space, and safety standards is now available from the committee, whose

*Gas chromatography of seawater-soluble fractions of various oils, by D. B. Boylan and B. W. Tripp of Woods Hole Oceanographic Institution. From top to bottom, the starting materials were: kerosene; No. 6 fuel oil; Kuwait crude; La Rosa crude; Louisiana crude. The ratios between the amounts of the two isomers of methyl naphthalene, and of the three isomers of dimethyl naphthalene, are characteristic of particular oils, and could perhaps help in the attribution of marine oil-spills. (*Nature, *March 5, 1971, p. 47)*



chairman is Robert Michaud, an M.I.T. senior studying civil engineering: his colleagues as of present writing include students from Worcester Polytechnic Institute, Tufts University, and the University of Connecticut.

Who Spilled the Oil?

The more famous marine oil spills have been clearly attributable to specific ships and rigs. Nevertheless, this is not true of the majority of spilled oil, which raises the classic question: Whodunnit? It is the old forensic problem of discovering something in the evidence that uniquely identifies the culprit. At the annual meeting of the American Chemical Society in Los Angeles, various methods were expounded.

At Woods Hole Oceanographic Institution the central approach is gas chromatography. Crude oil consists mainly of a very large number of hydrocarbons, in proportions which vary depending upon the place of origin. A project which started out as an investigation of the solubility of crude-oil components in seawater (of interest in relation to effects on marine life) led to the discovery that a seawater solution obtained from a particular crude could be used to identify the source of the crude: "an excellent, sensitive method," D. B. Boylan and B. W. Tripp called it in a recent paper in *Nature (March 5, 1971, pp. 44-47).*

As specific clues to an oil's origin, they drew particular attention to the ratio between the two isomeric forms of the double-ring molecule methyl naphthalene, and likewise that between the isomers of dimethyl naphthalene. Whatever "weathering" processes may happen to these compounds in the open sea, isomers should be affected equally and the ratios should remain unchanged. At the A.C.S. meeting, Drs. Max Blumer and Manfred Ehrhardt, also of Woods Hole, pointed out that straight-chain molecules could be used in the same way; a useful clue, for example, was the ratio between the amounts of pristane ($C_{18}H_{38}$) and *n*-heptadecane ($C_{17}H_{36}$).

Martin Lieberman and Leonard Berkowitz, of Esso Research and Engineering, Linden, N.J., consider that, to optimize such identification techniques, it will be necessary to simulate the weathering process in the laboratory, to discover which of the proposed "chemical tags" are stable. They foresee that "a considerable vocabulary of natural petroleum constituents will be available."

According to another school of thought, however, "weathering" alters the composition of a crude oil so radically that the idea of looking at the major components seems unpromising. Dr. F. K. Kawahara, of the Environmental Protection Agency's Water Quality Office in Cincinnati, proposes instead to look at the oil's minor components. He described to the A.C.S. a technique for extracting the weak acids from oil samples, followed by, again, gas chromatography. The chromatograms proved sufficiently characteristic to distinguish three samples of weathered crude gathered in different parts of the Gulf Coast region, and to discriminate among five different No. 6 fuel oils.

Thomas P. Meloy and Garth T. Gumtz, of Meloy Laboratories, Springfield, Va., reject both of the above approaches, which can be classed as types of "passive tagging"—that is, making use of clues that are provided ready-made. Even if oils could really be identified in this way (which they doubt), they point out that the typical tanker captain would answer somewhat thus: "Yes, I carried Kuwait crude and, yes, I was in the vicinity, but I did not spill the oil, the evidence is circumstantial." The alternative is "active tagging"—putting identifiable substances into the oil at each tank farm (field or refinery) and in each tanker. The mix of tagging substances would form a code, readable by some analytical technique.

What should the code physically consist of? Meloy and Gumtz reject radioisotopes ("infeasible on technical and political grounds") and find chemical tagging similarly problematical (both refiners and conservationists would have many objections). They suggest using particles—microspheroids about 10 microns in diameter, probably made by spray-drying or some other well-established technique. A 100,000-ton tanker would need only 50 g. of particles for an overall count of 1000 per liter. Particles would be identified by a combination of properties observable by visual observation, spectroscopy, and physical tests. These properties could be organized into a code of the required bit-length to specify even individual tankers.

Out of Sight, Out of Mind

All large cities by the sea—and some far inland—sense the temptation: dump solid waste in the ocean. It sinks, and is gone.

If rationalized at all, such a system must be governed by one of two philosophies: the solid waste is dumped into deep water, concentrated in a small volume of ocean which is thereafter "written off" for any other purpose; or the solid waste is distributed in such a way as to encourage decomposition so that the ocean can serve as a link in the natural process of returning waste materials to the life cycle.

Is either approach justified, and if so, which one? After two years of study, an interdepartmental task group at M.I.T. opts for dumping compacted bales of waste at sea as the most economical—

and probably safe—method. The ecological effects? No one knows for sure. Indeed, the research group's report to the National Council on Marine Resources and Engineering Development, sponsor of the study, contains more questions than answers.

One alternative is to simply dump loose refuse into the sea from barges. Half of it may be paper, which either floats or remains suspended near the surface. A large area of the ocean may be affected, but much waste is likely to be "quite easily" decomposed in the ocean environment. This may be the best way to use the ocean for returning wastes into the life cycle, but proponents have to contend with the "sociological effects" of trash, and crucial information on decomposition rates and routes is almost totally lacking.

Waste compacted into bales heavy enough to sink (64 lbs./cu.ft. or more), and solid enough to avoid disintegration in transit to its ultimate resting place, is economical. If the bales are dumped in at least 200 feet of water there is reasonable assurance that they will not be moved by force of tide or wave. The apple on the *Alvin*—edible after being submerged at 4,500 ft. for nearly a year—suggests that decomposition will be very slow and ecological effects limited.

Waste incinerated at sea, with the incinerator residue deposited on the sea floor, raises its share of unanswered questions, some having to do with weight and dispersion. Only one study of biological effects—by the Harvard School of Public Health—is known; it suggests that incinerator residues will have no long-term effects on ocean life and no serious short-term effects outside a prescribed dumping area.

But the M.I.T. group—whose study was conducted under the overall supervision of Alfred A. H. Keil, Head of the Department of Naval Architecture and Marine Engineering—could find "no short- or long-term studies on the effects of raw solid wastes deposited in the marine environment," and it insists that such research is necessary before any sea-based disposal system is adopted.

ELECTRONICS

Edison Superseded?

Such is the pace of technological change, it may be that the carbon-grain microphone will become obsolete within a hundred years of its invention (in 1877, by Thomas A. Edison). "At long last an economical alternative seems to be coming along," writes Julius P. Molnar, Executive Vice-President of Bell Laboratories, in a recent issue of Bell Laboratories *Record.*

The carbon microphone has intrinsic high gain. Replacing it with a twentieth-century, higher-fidelity microphone will mean adding an amplifier to the set; this will perhaps become feasible as integrated circuits grow cheaper. "Integrated circuits are also becoming economically attractive for generating Touchtone® dialing signals, for replacing the hybrid coil, and for driving a tone signal device in place of the bell ringer. Thus, before long," Dr. Molnar thinks, "*electronic* telephones will be replacing today's station sets."

On the other hand, as Mr. Dooley once remarked, not so fast. The first electronic telephones will cost more than the present kind. The owner will not benefit greatly from the higher fidelity, particularly if the person on the other end is still an Edisonite. And, "finally, some of the advantages (e.g. low ringing currents) will be realized only when the central office switching system can be changed as well."

The Air-Pollution Instrument Market

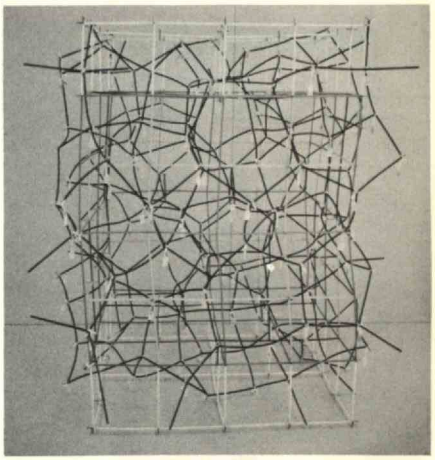
The national air pollution control program requires that pollutant output be measurable. Not all the required inexpensive instrumentation is available, and the Environmental Protection Agency has contracted out to Esso Research and Engineering a study of what research and development will be needed. Rene R. Bertrand, of Esso's Government Research Laboratory at Linden, N.J., reported some findings to the Institute of Electrical and Electronics Engineers' convention.

He concentrated on the measurement of emissions from stationary sources. The total instrumentation market during the 1970's in the stationary-source field is estimated at $250 million—"over half of the 10-year market estimated for all air pollution measurement instrumentation." (The $250 million is broken down into categories of task in the December issue of the *Journal* of the Pittsburg-based Air Pollution Control Association.)

Substances that need to be measured are: general particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons, and fluorides. Ideally, an instrument should be sensitive to the whole range of concentrations at which these substances are emitted, and should operate without trouble in the mouth of an industrial smokestack. Furthermore, the stack may be up to 20 ft. across, and its emissions will not be uniform throughout its cross-section, so two kinds of measurement must be made—a point sampling plus a sectional profile. The object, of course, is to discover the rate of emission in weight per unit time.

There is a third kind of task: measuring the emissions of diffuse sources such as oil refineries. In addition, the Environmental Protection Agency will need some kind of remote sensor to check on how well the job is being done—"a real and current challenge to your industry."

Plastic-rod model of the structure of amorphous germanium, built on the basis of a computer simulation by D. Henderson of I.B.M., San Jose. The model represents 64 atoms, each of which is marked by a four-rod junction. Although an amorphous material lacks regular crystalline structure, all bonds have preferred directions, which will tend to be obeyed locally. Computer simulation of the consequent mutual adjustments is one route towards a theory of the amorphous solid state.



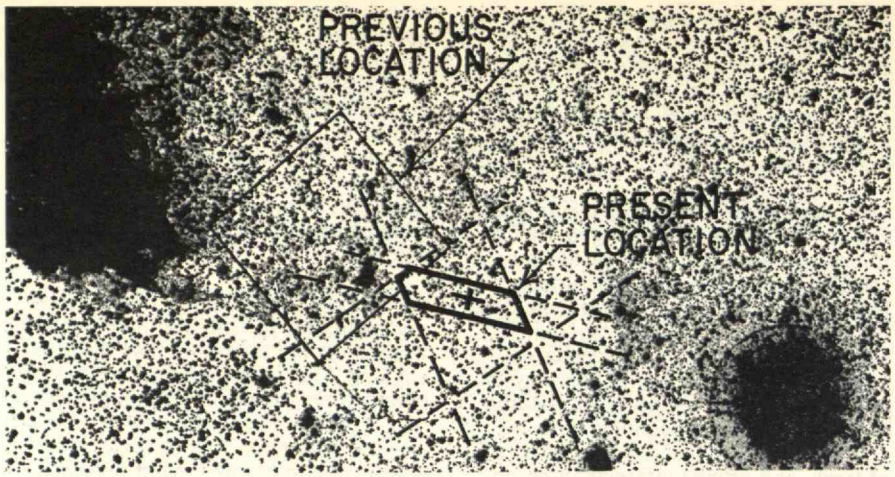
PHYSICAL SCIENCES

The Electronics of Shapelessness

Until recently, solid-state electronic devices have had to be made from crystalline material, carefully prepared so as to be highly regular in structure and to contain very precise quantities of impurities. But, about three years ago, S. R. Ovshinsky announced that he was getting useful electronic performance out of solids that were essentially just glasses—they had no particular crystal structure and only very roughly defined compositions.

The initial wave of skepticism has now been succeeded by a flurry of serious work in serious places such as I.B.M. and Westinghouse. The forthcoming International Conference on Amorphous Semiconductors, scheduled for August at Ann Arbor, Mich., had by early April received about twice as many abstracts as there will be room for. Some examples of the kind of work that is going on were presented at the March meeting of the American Physical Society in Cleveland.

Operationally, the amorphous semiconductors have so far been switches—when subjected to a voltage greater than a certain threshold, their resistance abruptly falls. They can be either "memory" switches, which remain switched on after the initiating voltage is removed and require another pulse to



Is this a picture of the elusive "black hole"? Data from the satellite Uhuru reveal a pulsing X-ray source in the constellation Cygnus—but no observable radio pulses coming from the same location (the heavy, small parallelogram, presumably a more accurate location for the source than was reported in 1967, the larger, lighter square). The absence of radio pulses suggests a "black hole"—a postulated star remnant so dense that radio and light waves cannot escape its intense gravity. (Photo: New York Times *from American Science and Engineering, Inc.)*

switch them off, or "threshold" switches, which remain on only as long as the threshold voltage is maintained. (Electronic logic circuitry consists largely of switches.) But the physical mechanism of amorphous switching is still subject to debate.

At the Pittsburgh Laboratories of Westinghouse, E. A. Dancy and D. W. Deis have discovered that the same device can be worked as either a memory or a threshold switch, depending on the details of the associated circuit. So, they tentatively deduce, "the difference between the two types of switching is more a question of degree and not of kind." Deis and Dancy are now studying a whole series of different chalcogenide-halide glasses—a variety of elemental compositions, with varying atomic ratios in each case—in search of generalizations as to which glasses are the switches and which are not. (For example, As-S-I glass is an insulator; As-Te-I glass is a switch material.) So far, there seems to be a connection between switching ability and unbiassed resistance. "We hope," say the Westinghouse workers, "to trace various trends in resistance and switching characteristics as we substitute atoms in these systems."

As M.I.T.'s David Adler observed in his article "The Amorphous Threat" (*see* Technology Review *for May, 1969, pp. 24-27*) conventional crystalline semiconductors lend themselves readily to theoretical analysis, insofar as they consist of simple "cells" identically repeated; whereas "theoreticians are not ecstatic over the idea of working on problems as intractable as that of 10^{23} atoms arranged at random." But an I.B.M. theoretician at San Jose, Calif., has made a start with 64 randomly arranged atoms of a single element, germanium.

"Randomly arranged" is not as simple as it sounds. However chaotic an assembly of atoms may be, it is necessarily constrained by the interatomic forces characteristic of the particular element—it is a compromise between total disorder and the inherent ordering power of the atoms. What kind of compromise this will turn out to be is not theoretically obvious. So Dr. Douglas Henderson of I.B.M. set up a computer simulation.

The computer starts with a model of 64 germanium atoms scattered throughout a cubic "box." It considers one atom at a time, moving that atom's four nearest neighbors to positions approximating a symmetrical tetrahedral arrangement around it. Going once around the box this way means moving nearly every atom back and forth four times, and the positions will still be only slightly more realistic than the starting arrangement. Another cycle therefore moves them all again—and so on, until the atoms reach a sufficiently satisfactory compromise so that yet another cycle makes very little difference to their positions.

The result, says Dr. Henderson, agrees excellently with X-ray diffraction studies of real amorphous germanium. Since it is a more detailed model than could be *deduced* from X-ray diffraction, it offers the electron theorists a useful starting point.

Another I.B.M. scientist wonders whether some "amorphous semiconductors" are all that amorphous anyway. H. M. Brodsky, of the Thomas J. Watson Research Center at Yorktown Heights, N.Y., working with Harvard's Professor David Turnbull, finds that "an examination of many measurements reported in scientific journals reveals that experiments believed to have been performed on glasses were in reality probably performed on crystals."

How could that have happened? In order to make electrical measurements on a semiconductor, it is necessary to fit it with metal leads. Brodsky and Turnbull note that, with some combinations of semiconductor and metal, the two will form a eutectic solution at the interface, enabling the semiconductor to flow (on a microscopic scale) and then resolidify in the more favored crystalline arrangement. This is likely to happen at much lower temperatures than it would if the semiconductor were initially crystalline. So, Brodsky and Turnbull sternly conclude, "people studying the properties of glassy silicon or germanium must be very careful in their selection of metals for use as contacts." Otherwise the amorphous state may be given credit where it is not due.

Flaring X-ray Stars and a "Black Hole"

The flowering of X-ray astronomy, widely predicted to occur when X-ray observatories could be flown by satellite above the earth's absorptive atmosphere, is arriving—perhaps a bit ahead of schedule.

Data obtained last October from the highest-flying balloon experiment ever launched (*see "Trend of Affairs" for March, pp. 54-55*) has now been analyzed by Walter H. G. Lewin, Associate Professor of Physics at M.I.T., and his associates. It reveals a previously unknown, rapidly flaring-and-decaying source of X rays in the constellation Centaurus that is strangely unlike any other known X-ray source in the heavens.

While Dr. Lewin was reporting his new finding in lectures in the Netherlands, Israel, and Italy—and in a paper to the *Astrophysical Journal*—a second team of Cambridge radio physicists from American Science and Engineering, Inc., reported its first results from X-ray detectors aboard Explorer 42, the U.S. satellite Uhuru: Cygnus X-1, a known X-ray source in the constellation Cygnus, is actually emitting its X rays as a stream of pulses arriving at a rate of at least 15 times a second. No other radiation—visible or radio energy—is associated with the source.

Riccardo Giacconi and Herbert Gursky of A.S.&E. now postulate that Cygnus X-1 represents a long-postulated class of object termed a "black hole," never before observed—a collapsed star whose remnant is so small and dense, and its gravity so immense, that no radiational energy can escape; the observed X rays come from a "pulsar" effect of the spinning, intense gravitational field.

The Centaurus source identified by Dr. Lewin, Jeffrey E. McClintock, and George R. Ricker, Jr., of M.I.T.'s Center for Space Research, is unique for the magnitude and brevity of its flares. Its X-ray output in one second of flaring is about a million times greater than the total energy released by the sun in the same

length of time; the flares recur with a period as short as 15 seconds. Dr. Lewin regards this extreme intensity as an indication of staggering celestial explosions. But he admits that such a phenomenon can, at the moment, be no better understood than any other aspect of the 40 known sources whose radiation is far more intense at X-ray wavelengths than in the visible light range. Professor Lewin postulates that many thousand more such sources await discovery from satellites coasting above the earth's atmosphere, and he is certain that flaring such as occurs in the Centaurus source will be observed in many others. Indeed, he now suspects that flaring may be a typical characteristic. Its discovery, he says, "will almost certainly help us in the understanding of what physical processes are at work in X-ray stars."

LIFE SCIENCES

Odorous Comparisons

A Frenchman wrote in 1880 of odors "saucy and sometimes tiring in brunettes . . . sharp and fierce in redheads . . . [and] heady and pervasive in blondes like the 'nose' of some flowery wines. . . ." An extravagant imagination? Perhaps, but certainly smell is a sense that finds less favor in these days of daily showers and specific deodorants. Yet, while our conscious approval of body odors declines, research begins to show that we are as endowed with odors and responses to them as other animals.

Dr. Alex Comfort, a gerontologist at University College in London and something of a popular sage, traces the course of study in *New Scientist and Science Journal (February 25, 1971, p. 412-414).* Dr. Groddeck, Freud's "bright but odd pupil," suggested that our sense of smell was quite as acute as that of dogs but that we repress it for psychosexual reasons. Two particular scents in perfume—musk and civetone—we find to be remarkably similar in structure to some mammalian sex odors (see diagram). And there are compounds related to musk which can be perceived only by adult women—immature girls are receptive only when given estrogen, and men not at all. Sensitivity also varies with the menstrual cycle.

A study by Martha McClintock at Harvard showed that close female friends who lived together (in residence halls) tended to fall into synchrony in their menstrual cycles. Dr. Comfort suggests that this accord may well be reached through communication by smell —an influence already known in female mice. Further, the women's cycles were shortened by contact (of an undefined sort) with males.

It was found ten years ago that the odor from a strange male will cause a pregnant female mouse to absorb her fetus and return to heat. Dr. Comfort proposes that odors from strange (or nonfamilial) males may also have an effect on human females. The age of puberty in girls has varied over several years in the past few centuries—coming down in our culture. The highest recorded average age was in the nineteenth century in those places where purdah survived, separating the girls from any males outside their own families.

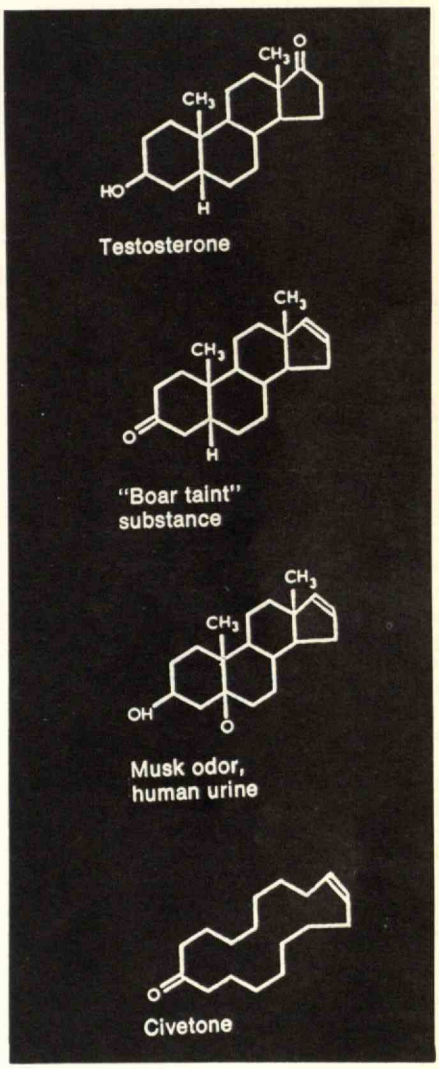
Human body hair, he continues, may have first been meant to diffuse scents—prominent tufts are placed above some of the apocrine glands, some of which produce sweat while others (in the regions of the pubis and aureola) "must presumably produce something else." Apocrine sweat is largely responsible for the odor of a clean body (sharp-nosed medieval authorities, according to Dr. Comfort, describe the "odor of chastity" —no mere figure of speech—as resembling ionone, and its opposite as resembling boiling starch). Work that Dr. Comfort views as supporting Groddeck's thesis has shown that infants and children respond to these scents as they grow. Thus, the oedipal phase of a boy's growth is accompanied by an increased sensitivity—and aversion—to the adult male odor.

Human pheromones—hormones that are received orally or olfactorily—like animal pheromones, are not only sexual. Schizophrenics claim to smell hostility; psychiatrists claim in turn to smell schizophrenia, and indeed a substance has been identified that causes this smell. A correspondent to *New Scientist* points out that another human pheromone, perceived by dogs at least, is stimulated by fear; others, perceivable by humans, he found to be occasioned by illness and anxiety.

Pheromones in animals or humans work in two ways—by inducing a specific reaction, or by preparing the body for a specific reaction. (The change of timing in estrus cycles is an example of the latter; the inducing of hostility, one of the former.) This duality complicates analysis of pheromones in humans, as the latter type, called a releaser, can imprint a pattern of behavior so that it becomes a conditioned response, liable to be confused with other conditioned responses—for some people the smell of gasoline rubber is a sexual stimulant, from its association with contraceptives.

Giving contraceptive pills to female monkeys will inhibit the sexual response of male monkeys. That a similar effect in humans is not expected is ascribed by Dr. Comfort to the very diversity of responses and stimuli that probably led to the enfeeblement of some of our sensory organs. We now rely on so many other cues that even new "intimate" deodorants ("the latest horror") are not unlikely to be overridden.

A number of substances, whose perception by smell is somehow related to sex, have similar structures. Civetone and musk are commonly used in perfumes; civetone is more easily smelled by women. Women can also perceive an odor called boar taint in pork more easily than men; it is closely related to the substance responsible for the musky odor of urine. Testosterone has no obvious odor, in spite of its related structure.



The copepod Calanus *is one of the larger varieties, about ⅛ inch long. Its oil sac, the patch near the tail, stores wax to supply him energy through long winters.* Calanus *is near the bottom of the marine food chain, feeding on algae and being eaten by larger fish. In this intermediate step, it processes about half of all the energy produced by photosynthesis in the world.*

Getting to Know The Brontosaur

Disneyland has got it all wrong about the brontosaur—as have most of the rest of us—for it appears that the huge animal supposed to have thrashed about in the Mesozoic rivers and swamps instead lumbered through the forests. An examination of some simple anatomical clues suggests to Robert Bakker, a paleontologist at Yale (Nature, *Vol. 229, pp. 172-4*), that the animal behaved much as elephants do today.

Their feet, first of all, were compact, with short toes that could not have given much support in soft, wet ground. Elephants, Dr. Bakker notes, have a similar foot, and take great care when walking on soft terrain. The brontosaur's knee, again like that of the elephant, was quite rigid compared to his forebears' knees, and his legs were elephantine indeed—sturdy and straight. (A weaker limb, in contrast, would have indicated that his great weight was often supported by water.) The brontosaur possessed also a strong back with short, stout vertebrae and heavy ligaments.

The brontosaur's long neck, which could raise his head some 40 feet above ground, is presumed by Dr. Bakker to have been more suitable for nibbling on a choice of shrubs and tall trees than for grazing on water plants. (The elephant achieves a similar, but lesser, capability with his trunk.) True water animals of that era and this tend towards short limbs and short necks.

Some brontosaurus skeletons have been found with numbers of small stones between their ribs. This leads Dr. Bakker to suggest that a gastric food mill might have enabled them to chew up small animals and tough greenery in their stomachs. (Their teeth were adequate for little except softer vegetation.)

The animal did not have the physical equipment associated with swimming, such as a properly propulsive tail. Although he did have a feature that would have aided his life in water—large breathing holes placed high on his head—Dr. Bakker points out that those animals bearing the closest resemblance in this respect are in fact land creatures. Most inhabitants of the water possess small holes placed low on the head.

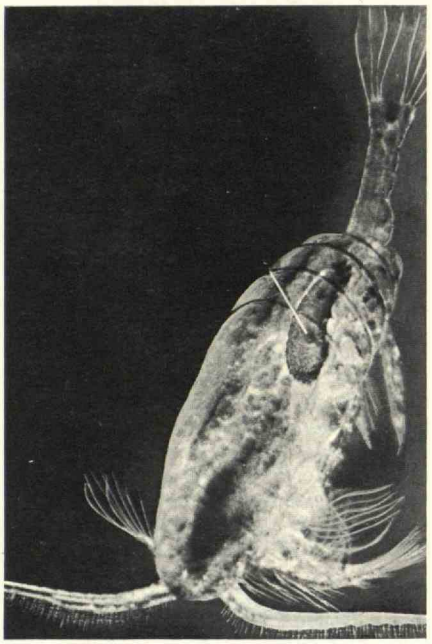
As final evidence, he notes that brontosaur skeletons in the Morrison Formation in Wyoming and Montana were found in the deposits of flood plains, rather than lakes and swamps. Many diverse forms have been found, and this variety of adaptation, he suggests, is more to be expected from the greater variety of terrestrial environments as compared with aquatic ones.

Getting to Know the Copepod

The brontosaur (*above*) was one of the biggest animals ever to live on earth; the copepod is one of the smallest. Its chief interest lies in its position in the food chain: half of all the energy produced by all the world's photosynthesis resides for a time in the copepod's oil sacs. The copepod lives in the sea and is small enough (sometimes 1/140,000 of an ounce) to feed upon tiny algae. The most numerous and diverse of all sea creatures, its numbers off the California coast alone contain some 800,000 tons of liquid wax—much more than the oil in either the Torrey Canyon (118,000 tons) or Santa Barbara (70,000 tons) spills.

It is the copepod's use of fat and wax that interests Dr. A. A. Benson, a marine biologist at the Scripps Institution of Oceanography, La Jolla, Calif. Most energy transfer among animals on earth—and most energy storage—is through fats. The copepod, Dr. Benson's group has found, is rather like a swimming tank-truck; it can be about 60 or 70 per cent fatty compounds, mostly wax.

Larger animals at sea, he suspects, use such compounds (lipids) to satisfy needs other than just energy. Desert animals have been found to oxidize fat to obtain water; sea animals, which like us cannot drink the brine they swim in, probably also get their water by burning



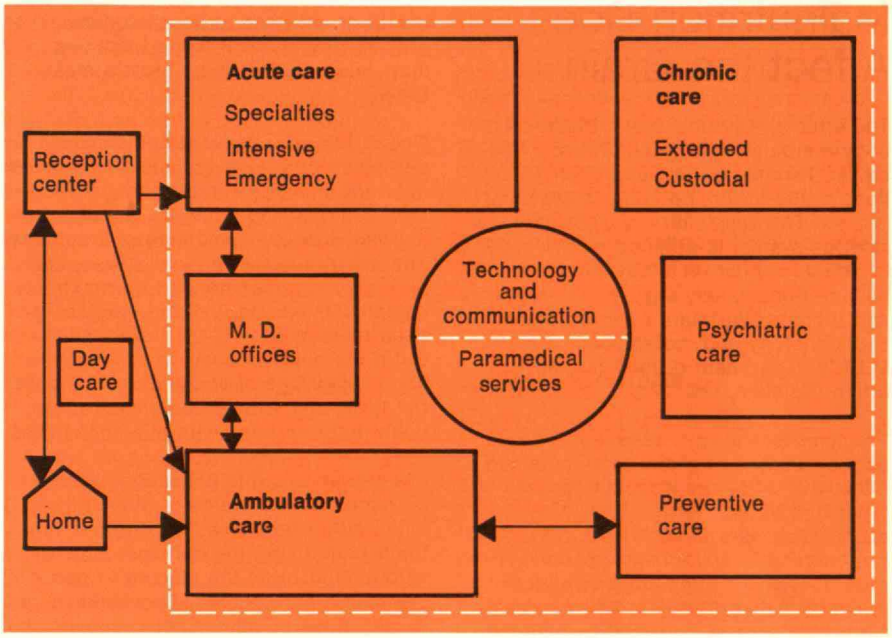
fat. Lipids in the form of wax are harder to break down and use than the usual fats, so wax probably sustains the copepod for long periods when meals are scarce. Thus, the copepod can make his home near the Antarctic or the Arctic, even through the winter, or thousands of feet under the sea, and survive. The more vulnerable fish—young salmon, herrings, sardines, and anchovies—that eat the copepod convert the waxes back to the simpler fatty acids.

How the copepod makes the change from fatty acids to waxes and how the fish perform the reverse process are still open questions. Dr. Benson suspects that the latter process is simple, probably involving the phospholipids of the intestine, and similar to certain reactions in higher animals. The compound intermediate between the simple fatty acids and the fatty alcohols of the wax is a fatty aldehyde, also to be found in the tissues of the human heart and brain. Some 70 per cent of the phospholipids in the mitochondria (the main site of oxidation in the cell) of heart and brain contain these fatty aldehydes, but their presence and function in man has never been explained. Dr. Benson hopes his research with copepods will help.

A plan for the hospital of the future, envisioned by Dr. David Rutstein of Harvard Medical School, would arrange health services centrally around technological and manpower resources for greater efficiency and convenience to patients and physicians alike. A special transportation system coordinated through neighborhood reception centers would speed patients to the proper place for treatment of specific problems.

Fitting Medicine to the Real World

No matter how much money Congress makes available, contends Dr. David D. Rutstein of Harvard Medical School, Americans will continue to get less than their money's worth of health services as long as the doctors and hospitals remain as disorganized as they are now. In a series of lectures at M.I.T. this winter, Dr. Rutstein sketched out an alternative system, partly based on the one that works so well in military combat areas.



His fundamental axiom is the need to "use our physicians and our scientific, social, and medical resources, institutions, and specialization to minimize disease, disability, and death" for every segment of the population, within the constraints of existing facilities, limited personnel, and rising costs.

To obtain economies of scale, the nation would be divided into "medical marketing areas," determined not by political boundaries but by transportation networks and the availability of facilities. Within each area, a central hospital would be equipped for the more expensive and specialized procedures (avoiding wasteful duplication), and "community" hospitals would deal with the more common ills. (Note in the chart above that doctors' offices would be located within the hospital complex). Exchanges between hospitals of general physicians, specialists, specimens, patients, information, education, and electronic impulses would further increase the efficiency of care.

An immediate pragmatic possibility for beginning such a system exists in the field of emergency care, where Dr. Rutstein would draw on the military system of having designated places for treating specific surgical and medical emergencies. There need be only one areawide phone number—and hence one entry point—for all medical care. A communications center, staffed by specially trained paramedical personnel, would decide on the need for care and would have at its disposal a specialized transport system—including ambulances and helicopters—to speed patients to the appropriate hospital, which would already be alerted to the patient's arrival. These vehicles would be staffed by the civilian equivalents of medical corpsmen, trained to meet all immediate emergencies. All this requires public acceptance of the military's experience that the way to save lives is to give lifesaving treatment at the accident site and to move the patient quickly to a doctor.

Regional ambulatory care would be the next step. This includes early management of illness plus prenatal and well-baby care. Currently there are neither specific facilities for ambulatory ("out-patient") services nor health insurance to cover the highly unpredictable costs. The greatest gap in the American health care system, said Dr. Rutstein, is that there is no "systematic way to take care of people efficiently 'on the hoof,'" thereby saving money by keeping people out of hospital beds.

Given the proposed emergency system, Dr. Rutstein would add neighborhood reception centers staffed by corpsmen, public health nurses, and social workers to provide easily accessible personal contact, screening for appropriate services, appointments, and transportation, if necessary, to ambulatory care centers located in the hospital complex. The plan should provide a better overall level of medical care at a lower cost per patient. Dr. Rutstein noted that many areas are now without physicians because doctors cannot practice without access to technical resources. Consequently, if there were centralized facilities adjacent to the hospital and efficient transportation, we would no longer need a doctor in every town.

Current proposals before Congress (like many in the past) make more money available but have no built-in controls on the quality and efficiency of the results, said Dr. Rutstein. He proposed a way to formulate national standards of health care. Local professional councils would be responsible for matching local performance to these national goals and could also recommend changes in the standards. This, he feels, is the most radical part of his scheme—to give both doctor and patient a means of evaluating the performance of the system.

Rats born and nursed by mothers whose diets were deficient in protein were found by two M.I.T. researchers to have smaller amounts of two brain chemicals, norepinephrine and dopamine, which are necessary for the transmission of nerve impulses. The study indicates that malnutrition might well stunt mental and psychological growth. The groups labeled C were well-fed; those labeled D had the deficient diet. (In the first column, the first of the paired letters indicates the parent rat, the second the nursing rat.) The baby rats were sacrificed in two groups, at 12 and 24 days. The chart shows the amounts of the two chemicals by weight found in the tissue analyzed.

Experimental group	Number	Weight (g)		Amount (μg/brain) of catecholamines	
		Brain	Body	Norepinephrine	Dopamine
			12 days		
C-C	8	1.30	38.5	.353 ± .029	
D-C	8	1.23	35.6	.366 ± .021	
C-D	4	1.01	12.5	.341 ± .010	
D-D	4	0.95	11.9	.311 ± .039	
			24 days		
C-C	23	1.63	79.5	.397 ± .023	.510 ± .008
D-C	10	1.61	77.3	.368 ± .010	.500 ± .005
C-D	10	1.36	30.8	.342 ± .018	.410 ± .005*
D-D	26	1.12	17.3	.287 ± .012*	

* Differs significantly from C-C group.

Malnutrition Does Affect the Brain

The effects of protein malnutrition on the body are painfully obvious; those on behavior, learning ability, and other functions of the brain and nervous system, less so. The suspicion has been that the nervous system is affected as the body is, and a mechanism is now tendered by William Shoemaker, a graduate student, and Richard Wurtman, a professor of endocrinology and metabolism, in M.I.T.'s department of food and nutrition (Science, *Vol. 171, p. 1017-1019*).

Pregnant female rats were fed as much as they wanted of a diet that contained either 8 or 24 per cent protein for the latter half of their terms. The litters in each group were then divided in half before nursing to make four experimental groups: well-fed pups fed by well-fed mothers, well-fed pups fed by deprived mothers, deprived pups fed by well-fed mothers, and deprived pups fed by deprived mothers. All litters contained eight pups, and no mother nursed her own.

Their bodies showed the familiar effects: the pups nursed by deprived mothers grew less than a gram a day, while their well-nourished brothers gained an average 3.5 grams. The content of the mother's milk was not affected, but the quantity was.

But the neurological effects were also evident: the brains of the pups borne and nursed by deprived mothers produced significantly smaller amounts of two catecholamines, norepinephrine and dopamine, than did their controls (*see table*). Catecholamines are chemicals that aid in the transmission of neural impulses between some kinds of nerve cells: as an electrical impulse travels down one of the long thin neurons, the cell releases norepinephrine into the gap between it and the next to carry the signal across. Without norepinephrine, the message does not move.

The brain neurons that so use this and other catecholamines have been implicated in mood, control of muscular activity, learning and other mental abilities, and general psychological growth. Any or all of these functions may thus be affected by protein malnutrition.

One of the enzymes that helps make norepinephrine and dopamine was found in larger amounts in the brains of doubly deprived rats, and not in the doubly nourished ones—something of a surprise. The enzyme, tyrosine hydroxylase, acts on tyrosine, an amino acid, to make the catecholamines; lack of the enzyme has been thought to limit their production. But if the enzyme exists in excess, perhaps a shortage of tyrosine itself imposes the limit, and a protein-deficient diet ought to be fortified with this amino acid.

The lesser amounts of catecholamines produced by the brains of deprived rats might either be caused by fewer of the brain cells using the substance, or by an overall drop in the amount of catecholamine per cell: Mr. Shoemaker and Dr. Wurtman could not determine which. But as few brain cells are produced after birth, the former would be irreversible. The latter might not.

Do I Dare to Eat a Peach?

The above question was asked, it will be remembered, by a gentleman who felt that he had already measured out his life with coffee spoons. He may have been right.

Sugar came to Europe with the returning crusaders, rare and costly as any Eastern spice. A European in those times felt lucky to posses a few ounces; now he, like us, eats two, perhaps three, pounds of sugar a week. Most of the rise has come in the last 100 years, and an English biochemist-physician suggests that this rise as nearly parallels the rise in heart disease as does that of the consumption of fats. A discussion of his supposition, and the mixed evidence, were presented in *Medical World News* (*February 12, 1971*).

Two or three pounds a week? Easy—two teaspoons in each of four or five cups of coffee a day, a few more on cereal, a bottle of cola or fruit drink, a dessert or two, and the total is reached. This is just refined sugar, or sucrose, from sugar cane or sugar beets. It must be converted by the body into the other forms, whereas the sugars in honey and fruits are the chemically different glucose and fructose, sugars that are absorbed into the blood unchanged.

But whether the effect of sucrose on the body differs from that of other sugars, and whether it is used differently, are far from understood. A few studies show a tendency for a diet high in sugar to produce a high level of fats in the blood (not necessarily cholesterol), and Dr. John Yudkin, the noted nutritionist of Queen Elizabeth College, London, suggests that sucrose exaggerates that effect.

But the response to sugar—or to too much of it—is an individual one, Dr. Yudkin says, and it is probably controlled by each person's mix of hormones. Some people might be very susceptible to a diet high in sucrose, others only slightly. Of course, how a person knows which he is, is as little understood as the question of the particular effect of sucrose.

The best evidence for Dr. Yudkin's suspicions of sugar and sucrose is epidemiological—the study of populations and disease. Populations tend, as they rise from the simple life, to eat more sugar and fewer complex carbohydrates or starches—the rise that Dr. Yudkin sees as paralleling that of heart disease. Dr. A. M. Cohen, of the Rothschild Hadassah University Hospital in Jerusalem, studied two groups of Yemenite Jewish immigrants; one newly arrived, and one arrived at least 25 years ago.

The earlier group ate a little more—and weighed a little more—although they had the same intake of protein. Fat intake differed—usually animal fats were eaten by the new immigrants, whereas the other group ate more fat but mostly vegetable fat. But Yemenites long in Israel had become fond of sugar, which made up about 20 per cent of the carbohydrates they ate; the new arrivals

ate almost none. The earlier immigrants had a significantly greater incidence of hypertension, diabetes, and serum cholesterol than the newcomers.

Other studies, of both animal and human populations, offer evidence that can be interpreted to support Dr. Yudkin's thesis, but any relationship between sugar and heart disease is so complicated by other physiolcgical and environmental factors as to be a difficult one to define. Yet the possibility of such a relationship does exist—adding credibility to the ideas of natural-food people who have inveighed against refined sugar for years. For those who wish to convert, honey can be substituted in any cooking or baking—use an equivalent amount, and for measures of over one cup, decrease liquid by 1/4 to 1/3 cup.

EDUCATION

Teach a "Capacity for Independence"

As problems on which engineers work become increasingly diffuse, involving issues in which technology is only one component of a solution, students need fewer facts from handbooks and more "capacity for independence," says Paul E. Gray, '54, Dean of M.I.T.'s School of Engineering who becomes Chancellor of the Institute on July 1.

The definition of engineering is the same today as it was 100 years ago when William Barton Rogers was founding M.I.T.; it is still "the application of scientific principles in creating systems that fulfill societal needs." The difference, Dean Gray told the Institute's Alumni Advisory Council early this spring, is in the problems with which engineers are now confronted: Their tasks are more complex, their solutions so interrelated with other societal problems that some people fear technology has developed a life of its own, becoming master instead of willing servant.

For students preparing to enter engineering practice under these conditions, Dean Gray prescribes a four-point program:

1. Develop a mastery of such basic skills as mathematics, chemistry, and physics.
2. Acquire practical knowledge and experience in some specific area of engineering. This must include, he said, problem definition and decision making on the basis of incomplete information—hence engineering synthesis.
3. Understand the interaction of engineering with the social, political, and economic environment in which it is conducted. Using an engineering term from his own professional field, Dean Gray suggested "feedback loops to provide sensitivity to social needs and priorities."
4. Develop a capacity for "self-renewal," which Dean Gray described as "the ability to formulate questions as well as answers, to recognize the need for new knowledge and then the ability to find it."

How to develop these qualities in an engineering curriculum? Not easy, Dean Gray assured his alumni audience—especially in times of increasingly rapid technological change and of financial constraints. But here are a few examples of M.I.T. responses:

◇ Freshman seminars and a program of undergraduate research activities, making it possible for students "to come to grips with real engineering problems, to learn what it's like."

◇ The pass/fail grading system for freshmen, to substitute self-discipline for the artificial tension of trying to reach someone else's goal. Reporting on present experience under a four-year test, Dean Gray suggested to his audience that "students are working no less hard under the system—but they are worrying less about it."

◇ Policy seminars to provide a dialogue on issues at the interface between societal needs, public policy, and technological progress.

◇ Increasing flexibility—ranging, for example, from many more first-year electives (at least 170 possibilities for today's freshmen each term) to programs for degrees without specialization which simply permit students to develop their own curricula (with faculty guidance and approval) suited to their individual interests.

Does such increasing flexibility and greater emphasis on societal issues decrease the rigor of an education? A risk, Dean Gray admitted. "But my impression," he declared, "is that the provision of greater self-selection and self-discipline leads to a stronger educational experience"—to that "capacity for independence" which is the real goal of engineering education.

Learn Now, Pay Later

The "pay as you earn" concept to allow students to defer substantial parts of their tuition payments for up to 35 years after graduation is catching the attention of higher education, college students, and their hard-pressed parents.

In the face of rising financial pressures, particularly at private universities and colleges, administrators are energetically seeking new ways to help students finance their education. If new ways cannot be found, some private institutions fear that they must sacrifice quality in order to control costs, or remain open only to those students whose parents could afford the rapidly increasing cost of a quality education. Loath to take either of these paths, many institutions—led by Yale—are investigating the potentials of "deferred tuition."

Beginning in September, 1971, Yale students will be allowed to defer—and pay at a later date—up to $800 of their annual college expenses: a new $350 tuition increase, the $150 increase in board and room to be effective next fall, and up to $300 of currently imposed charges.

How It Works

Students who want to take advantage of the plan will sign a contract (for which they are personally responsible) with Yale.

◇ The rate of repayment (fixed at four-tenths of 1 per cent of annual adjusted gross income for each $1,000 postponed)

Yale University's plan for deferring part of its students' tuition payments is different because it makes the university a partner in the graduates' success—or failure. The annual repayment, figured according to the formula given at the bottom of the table, is calculated to "allow Yale to realize the benefit of increased tuition income over the lifetime of a generation," according to the official announcement.

TUITION POSTPONEMENT OPTION
TABLE OF ANNUAL PAYMENTS

Annual Income	Postponed Amounts									
	$1,000	*$2,000*	*$3,000*	*$4,000*	*$5,000*	*$6,000*	*$7,000*	*$8,000*	*$9,000*	*$10,000*
$ 7,250 and under	$ 29	$ 58	$ 87	$ 116	$ 145	$ 174	$ 203	$ 232	$ 261	$ 290
10,000	40	80	120	160	200	240	280	320	360	400
15,000	60	120	180	240	300	360	420	480	540	600
20,000	80	160	240	320	400	480	560	640	720	800
25,000	100	200	300	400	500	600	700	800	900	1,000
30,000	120	240	360	480	600	720	840	960	1,080	1,200
40,000	160	320	480	640	800	960	1,120	1,280	1,440	1,600
50,000	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
75,000	300	600	800	1,200	1,500	1,800	2,100	2,400	2,700	3,000
100,000	400	800	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000

Note: Annual Payment = .4% (four-tenths of one percent) x Annual Income x Postponed Amount (in one thousand dollar units or percentage thereof)

is the same for everyone. A graduate whose income is $10,000 would repay $58 per year on a postponed amount of $2,000; a graduate making $25,000 per year would pay $200 annually on the same amount of postponed tuition.

◇ If a student wishes he may cancel this contract up to six months before graduation. His debt is then converted to an ordinary loan.

◇ If a graduate wants to pay off his indebtedness in a lump sum, he may elect to make a payment that brings his total payments to one and one-half times the tuition he postponed, plus an interest rate to cover Yale's administrative and borrowing costs.

◇ A female student who marries and has no separate income will repay Yale on the basis of half of her husband's earnings.

Yale estimates that students will postpone payments totaling up to $30 million during the first five years of the plan, and that between one-fourth and one-half of the student body will participate.

Yale is seeking a ruling from the Internal Revenue Service on whether or not all payments in excess of the principal amount deferred should be treated as payments of interest, hence deductible from gross income for tax purposes. "On this assumption, the effective burden of all but the minimum repayment of $29 per year would be greatly reduced. The reduction of the effective cost of repayment would be somewhere between 20 and 35 per cent of the amount being paid by the average graduate," said Yale President Kingman Brewster, Jr., announcing the plan.

The idea is catching on. Duke University will begin a somewhat modified version of the Yale plan next fall, and the Ford Foundation will spend $500,000 studying the Yale experiment next year to "test the application of the concept for a wide spectrum of both students and institutions." A deferred tuition plan proposed for state institutions in Ohio has been opposed in the legislature as an attempt to shift the cost of a public education from the state to the individual.

Educational Opportunity Bank

The "Yale Plan" is not the first serious look at deferred tuition. In 1967, Jerrold R. Zacharias, Institute Professor of Physics Emeritus and Director of Educational Research at M.I.T., chaired a Panel on Educational Innovation under the auspices of the President's Science Advisory Committee. Reporting to the U.S. Commissioner of Education, to the Director of the National Science Foundation, and to the Special Assistant to the President for Science and Technology, the panel recommended development of an Educational Opportunity Bank—a federal lending program for post-secondary students. Loans would be repaid after the student entered the work force by his pledging a percentage of future income for a fixed number of years after graduation.

Yale's plan shares many features of the Educational Opportunity Bank proposal, on which no federal action has yet been taken.

Calling the Yale plan "risky, but innovative" and "very interesting," President Howard W. Johnson of M.I.T. finds in this variation of the Zacharias plan "real merit." "It would be great if the Technology Loan Fund (which requires only that the principal plus interest be paid back, with interest lower than usual lending sources) could be expanded to $20 to $30 million." (Its total is now over $5 million, but more capital is needed.) Of the Yale plan, says President Johnson, "We're watching it very closely."

POLITICS

Data Processing vs. The Bill of Rights

Rapid advances in information technology and their utilization by government threaten an "information tyranny" which will seriously distort the balance of power between government and governed, a cornerstone of the U.S. Bill of Rights, Jerome B. Wiesner, President-Elect of M.I.T., has told the Constitutional Rights Subcommittee of the Senate Judiciary Committee.

Testifying early this spring, Dr. Wiesner warned that even present technology provides vast potential for collecting and correlating personal information. Indeed, he said, this capability could "undo that subtle balance achieved in the Constitution betwen the people and the state.

"To the degree that the Constitution meant for the power to be in the hands of the governed, the widespread collection of personal information poses a threat to the Constitution itself," he declared. There is also no doubt that technology can be and has been used to assist in the violation of the Bill of Rights. "To my nonlegal mind, there is even the question of whether the Bill of Rights, drafted in a simpler time, is adequate to protect man in his relation to the modern state, whether there isn't a need for additional amendments providing protection for the individual against possible new infringements of his liberties.

"We may have to adopt some stern measures in the form of very strict controls on who can do what with private information about any individual in the society," said Dr. Weisner.

To this end he listed four specific proposals:

◇ A watchdog authority to review public and private information gathering and processing activities within the country. It would examine the nature and extent of such activities and report its findings to the Congress and the public.

◇ Congress should set "rigid limitations" on surveillance activities and "much stronger safeguards than now exist" against misuse of data-file information.

◇ Action should be quickly taken "to reestablish public confidence in the sanctity of the boundaries of an individual's physical and psychological living space." This will require outlawing such activities as the free exchange of private information and collection of data not needed by an agency, acknowledging publicly the extent of permissible surveillance and by whom. And it will involve requiring disclosure of nonsecurity

data to the individual to whom it applies. In national security matters and in a few other sensitive areas, judicial controls should be strong.

◇ Technical means of insuring data security and safeguarding privacy should be developed vigorously and their use required.

"We should be prepared," said Dr. Wiesner, "to accept the cost of considerable inefficiency in our various social and governmental processes to safeguard our privacy and, as I judge it, our freedom, dignity, happiness, and self-respect."

Containing the Energy Arguments

Regarding the ongoing conflict between the planners of more electric power stations and the defenders of nature, the National Academy of Engineering offers two hopeful propositions. First, that the objectives of both sides can be accommodated by good engineering. Second, that all serious points of view can be brought together into a single public dialogue, from which should emerge at least a common frame of reference.

To this end, about a year ago, the Academy set up a project on power plant siting under the leadership of Dr. W. Deming Lewis, President of Lehigh University. As part of the project, an open forum was held in mid-March, attended by representatives of power companies, related industries, universities and conservation groups. And indeed, reasonableness generally prevailed in spite of the ideological chasms separating some of the participants.

Summing it up at end of the two-day forum, Dr. Lewis quoted with approval the observation of one speaker, that people have a constitutional right to seek what they want even though it may appear unreasonable to others. He also noted that the current "environment" outcry is still young: in the 1968 presidential campaign, none of the candidates even once mentioned the subject (a point made by Rep. John P. Saylor, of Pennsylvania).

The sharpest disagreement, said Dr. Lewis, was between those who thought that the demand for electric power ought to stop doubling every ten years and should level off, and those who did not think this was a plausible solution to the basic conflict. Even here, he thought, the disagreement was a matter of timing and magnitude rather than of principle.

Another area of disagreement related to how particular battles should be fought. Mr. David Sive, a New York lawyer, favored legal adversary proceedings: "In any environmental controversy involving the weighing of conflicting values, the weigher should be a court, a generalist, rather than an administrative agency whose outlook is organically developmental and provincial." The courts as they stand are not perfect for this purpose, but they offer a public arena and the possibility of cross-examining experts under oath, said Mr. Sive. The opposite opinion is that the question of what the public wants can be answered without recourse to the courts, and that once this is done, what remains is the purely engineering task of designing what has been asked for.

Dr. Lewis expressed himself both encouraged and puzzled by the suggestion that power plant planning should be combined with the rest of city planning—his puzzlement being occasioned by the question of what agency would be powerful enough for such an all-encompassing job, and by an apparent uncertainty as to whether power plants should ideally be near their cities or far away.

One point of general agreement was that power station planning at present involves too many agencies, any of which can say "no" but none of which can say "yes"; a "one-stop" agency, if it could protect everyone's interests, would be welcomed by all, it seems.

The N.A.E. power plant siting program continues. There are six working groups. Four are concerned with specific effects of power plants: air pollution, water pollution, radiation (including high-level nuclear wastes), and aesthetics and land use. A fifth group is concerned with "methods of systems engineering which might help to resolve the conflict between utility and environmental objectives," taking legal and political considerations into account. N.A.E. President Clarence H. Linder has described the project as essentially a short-term study, albeit a major exercise in Academy initiative. Nevertheless, the sixth working group considers "broad national implications of the conflict and of certain possible solutions such as restrictions in the use of power."

When the Lonesome Whistle Blows

Seeking to bell the cat, Mr. Nader has placed that multiproverbial animal squarely among the pigeons. He has set up in Washington a Clearinghouse for Professional Responsibility, which will collect information from professionals wishing to "blow the whistle" on company or state behavior that appears harmful to the public interest. Professionals are now wondering what to do about this new facility.

At the Institute of Electrical and Electronics Engineers' International Convention in New York this spring, one question was repeatedly asked at sessions relating to professional responsibility. It tended to go unanswered, and to be debated later by small knots of people after most of the audience had left. What protection is there for the engineer who makes himself unpopular with employers by taking some kind of ethically motivated stand? Would anyone even dare to be seen entering the door of Mr. Nader's establishment?

The question remained in the air. However, not everyone sees it as a legitimate question. One current view is that a salaried engineer's employer—however large—is his client, that the relationship is a confidential one, and that any breach of this confidence is itself unethical.

Without actually mentioning Ralph Nader, *Electronic Design*'s microwaves editor offers the following thought in that journal's admirably miniaturized April 1 editorial: Engineers repeatedly get into the news for either (a) being blamed for all manner of evils, or (b) being sacked in large numbers. In both cases, says Michael J. Riezenman, the point is that engineers control neither their work nor their careers. In spite of usually doing what they are told, they are laid off when they are not needed. So, says Mr. Riezenman, "While we don't want to suggest that taking responsibility for the consequences of your work will safeguard your job, we do feel that failure to take such responsibility will ensure that it will never be secure."

Deus ex Media

If you disliked Nader's Raiders, you'll hate Pedler's Meddlers.

Dr. C.M.H. Pedler is a department head at Britain's Institute of Ophthalmology. His professional reputation rests upon his electron-microscope studies of the structure and function of the retina. His extramural reputation rests first upon his work as scriptwriter for an outstandingly popular children's TV science-fiction series, *Dr. Who*. More recently, he has had a series called *Doomwatch* on the British Broadcasting Corporation's popular-TV channel, B.B.C.-1.

Doomwatch is a story about a gallant team of government scientists who prevent undesirable consequences of science and technology. *New Scientist*'s life-sciences editor, Graham Chedd, who interviewed Dr. Pedler for the March 18 issue of that weekly, feels that the series "descends too readily to the melodramatic," but allows that it "has undoubtedly got more about science and its concomitant dangers across to more people (some 12 million watch each program) than a host of earnest, learned documentaries."

The *New Scientist* article continues: "Pedler wants to see a real Doomwatch. Out of his 'science-fiction pipe-dream' has emerged the idea of a small, dedicated band of perhaps five or six scientists, each with a specific expertise, setting itself up as a sort of freelance watchdog against the misuse of science

Railroad freight service is definitely poorer than truck service. Yet, even with allowances for the service differential, one-fourth of the shipments now made by truck could be made by rail, were the rails permitted to scale their rates according to their costs and service. The costs for shipping by rail for distances of 50 miles to 800 miles, with different packages of service differentials, are compared with the costs of shipping by truck in the chart. Figures indicate cents per ton-mile. (Chart: Charles River Associates)

	Rail			Truck
Distance shipped, miles	Real costs of shipping plus all service differentials	Real costs of shipping plus service differential due to size of shipment and time in transit	Real costs of shipping plus service differential due to size of shipment	Total real costs (truck-load shipments)
50	$12.82	$8.33	$7.02	$8.80
100	6.65	4.40	3.67	6.00
200	3.51	2.39	2.00	4.80
400	2.01	1.45	1.18	3.85
600	1.48	1.11	0.88	3.27
800	1.21	0.93	0.74	3.24

and technology. . . . He would aim, in fact, to put a fly in the bland P.R. ointment used to soothe many of the wounds caused by the misapplication or lack of application of science and technology. And his fly will be the unvarnished scientific facts." The real Doomwatch will attempt "to predict the unhappy outcomes of apparently splendid ideas, rather than come along and sweep up the mess afterwards." It will use voluntary assistance from students and other technically trained enthusiasts, of which Dr. Pedler foresees no shortage.

Dr. Pedler is equally unworried about the question of funding. He hints that a few large private sources would be generous, and—writes Chedd—"once it has a success or two under its belt, the organization would appeal for funds directly from the public; science for the people, paid for by the people. In this way, it would avoid commitments to government or industry, and all political pressure."

ORGANIZATION

Railroad: Still Working on It

One estimate promises ten times as many truck shipments on the roads in ten years as at present—some 30 million. Yet the cost of even the present highway system is often questioned. A study by Charles River Associates for D.O.T. proposes some relatively simple changes in freight shipping, to divert perhaps 67 per cent of truck shipments to rails, at a general saving to society and to industry reckoned in the billions. (The report recognizes its recommendations to be a "political and legislative briar patch.")

The first, immediately effective change proposed is the release of the railroads from a cumbersome rate structure—a relic of the time when rail had a monopoly. Rail rates are about the same as truck rates, yet rail transport usually costs its operator less than truck, and truck transport offers better service. Were rails permitted to align their rates with their service and costs, Charles River predicts, 26.3 per cent of the load carried by trucks would fall to them, in spite of the railroads' presently poor service.

Most service differences can be described in technical terms: rail cars average 19.5 miles per hour on the line; trucks, 32 miles per hour. During a rail journey, stops are more frequent and require longer waits. A journey of 50 miles will take 52 hours longer by rail than by truck; one of 800 miles, 120 hours. Merchandise in rail cars is subject to more abuse than in trucks, from coupling and switching and from a generally bumpier ride. The railroads' dispatching service is poor: equipment is not necessarily available when the customer wants it, and often it cannot be traced in transit. Because a rail car must travel in a train, it must wait for suitable company before proceeding to its destination. The railroad cannot predict with accuracy when a shipment will be delivered.

In return for the freedom to equate rates with service, and for a little monetary encouragement, the railroads would —according to the Charles River proposal—conduct research for a better car, with new braking and coupling systems for faster switching with less labor, with a new suspension system, and with a longer reliable life. Work would also begin on a new control system for routing cars, and perhaps on inducing a generally greater spirit of cooperation among carriers.

The government could respond to these good works by offering job security and higher wages to labor, in exchange for eased union work rules. Without union cooperation, the report says, "improved railroad freight service [is] almost impossible to effect."

The 26.3 per cent of the market to be drawn by rate reductions is about half of the present shipments beyond 200 miles, the distance at which truck and rail costs presently match. (The longer the distance, the greater the railroads' advantage) Were the railroads to improve just two aspects of service—availability of equipment and dependability of delivery time—Charles River Associates predict the matching point could fall to 50 miles (see table). Allowing for the remaining service differences, shipping would then be cheaper by rail for the 66.6 per cent of all truck shipments that travels 50 miles or more.

The advantages are impressive. Rail freight cars carry between two and four tons of payload per ton of deadweight; trucks only 2.1 to 2.5. A freight train needs 3.15 horsepower per ton of freight; a truck varies from 2.13 to 11.33. Moving 50,000 tons from New York to San Francisco takes four times as much fuel by truck as by train. Highways need not be as sturdy nor as numerous without heavy trucking, nor maintenance as expensive.

A diversion to rail of 25 per cent of the tonnage moved by truck would have saved, in 1966, some $1 billion across the United States, just in highway construction. The savings to society in general for that year, if that 25 per cent had been shifted to rail and charged according to rail's actual costs (including service differentials), would have been $8 billion.

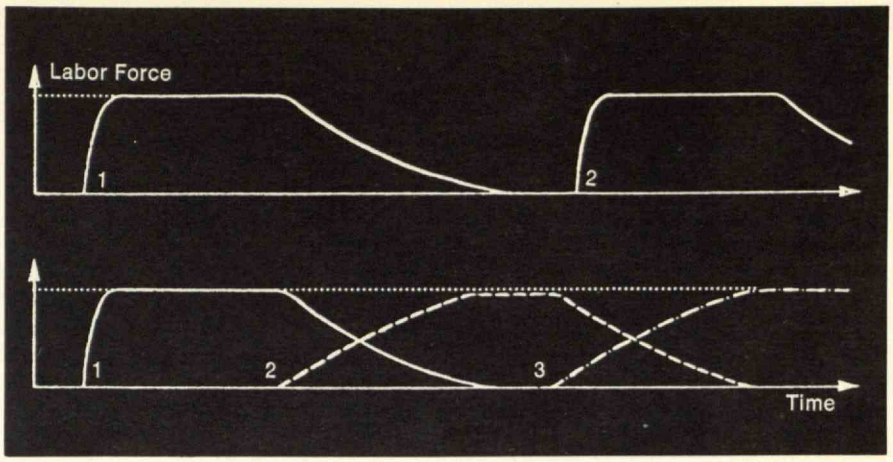
But in practice? In mid-April Mr. Aaron Modansky, president of the Freight Users Association of Long Island, accused the N.Y. Metropolitan Transportation Authority of deliberately trying to abandon freight service on the Long Island Railroad, by leaving freight for days in its salvage yards. Lumber from Mr. Modansky's timber operation (centered 25 miles east of New York City) had been "tied up for 11 days." He takes a dim view of the prospect of having to switch to road transport and pay extra.

The Decline of Private Power

Alan Pifer, President of the Carnegie Corporation of New York, devotes the opening portion of the Corporation's 1970 annual report to an eloquent plea for the nation's private institutions. They are in ill health, he says, and the time "is extremely late" for action to bolster them.

Mr. Pifer's argument is uniquely lucid. There are, he writes, four reasons why

If pyramids had been built only when required for specific kingly interments, the pattern of employment might have been somewhat as in the upper graph, with disruptive consequences. There is reason to believe that, instead, pyramid projects were timed as in the lower graph, establishing a continuous employment pattern during the century in which this was an important activity.



it is "a matter of compelling importance to retain in our society service institutions that are not under public control":

◇ Such institutions offer a special opportunity for citizens themselves to participate in many voluntary activities. Institutions' boards and committees, and the many workers whose activities are stimulated by them, are taking roles that would otherwise simply not be open to private citizens.

◇ Private institutions have a central role in preserving freedom—individual, artistic, intellectual, academic, professional. Because they are not directly dependent on public money, such institutions "are less immediately vulnerable to restrictions on their capacity to function effectively."

◇ The work now done by private institutions cannot well be absorbed by existing public ones. Indeed, were private schools, museums, and associations terminated today, tax resources would be simply insufficient to maintain most of their functions, even were government motivated to make the effort.

◇ Private institutions "bring to our national life vital elements of diversity, free choice, and heterodoxy." No suggestions of inferiority or superiority are implied by the statement, writes Dr. Pifer; he simply means to say that there are "a number of ways to accomplish something and in the long run the competition between several possible approaches is good for everybody."

The threat to private institutions obviously comes from a dramatically reduced difference between their income and their expenses in a time of economic recession. But it comes equally from a lack of concern for their welfare and their future throughout the U.S.—among "alienated" young people, among mistrustful "middle Americans," among government officials at all levels. Dr. Pifer believes that the first stage in a gradual decline of institutional effectiveness is already upon us; many, he says, "are incapable of a vigorous response to changed times." Such a "loss of cutting edge," writes Dr. Pifer, leads to the next stage (also upon us?), when institutions' own self-confidence and the public's confidence in them is jeopardized. Soon thereafter follow difficulties in recruiting staff and curtailments of basically important activities.

Can the present course be reversed? Dr. Pifer is far from optimistic. His only answer depends upon "a clear appreciation by the nation's top leadership of what the collective presence and vitality of these institutions mean to the nation." Such leaders, educating the public "rather than simply mirroring public ignorance and apathy," might yet provide the impetus "for the great variety of measures which will be needed to preserve and revitalize the position of our private institutions." Without such an effort, he writes, we "will almost certainly be living in a society where the idea of private initiative for the common good has become little but a quaint anachronism."

Up and Away with the Third Dynasty

The partial analogy between the Apollo program and the pyramids receives a boost from the thinking of the eminent British physicist Kurt Mendelssohn, published in *American Scientist (March-April, 1971, pp. 210-220)*.

Dr. Mendelssohn traces the evolution of the craft of pyramid building from the first to the last of the great pyramids. There are just seven of them, all constructed within about one century. After that, for the next thousand years, pyramids "rapidly became smaller and shoddier . . . the zest had gone out of pyramid building forever."

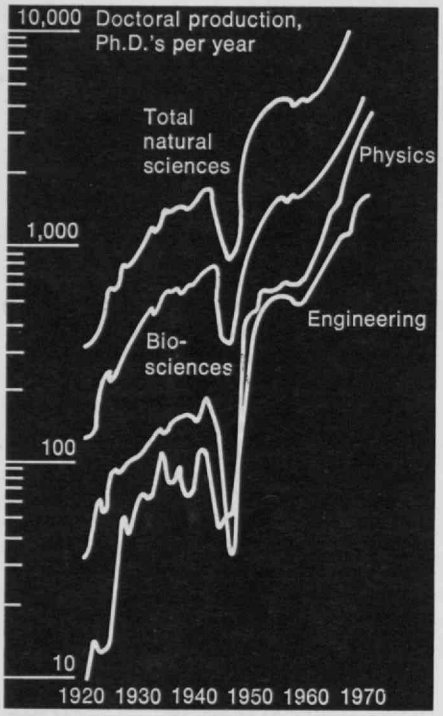
But why were they built at all? It is well known that during that brief period there were more pyramids than pharaohs. Dr. Mendelssohn deduces that although kings may have been buried in them, they were not primarily tombs. He also rejects the idea that they were built by slave labor, on the ground that 100,000 laborers, working seasonally (during the three-month slack season of the agricultural year), would not have been controllable even with the worst will in the world. He is a China-watcher—the author of *In China Now*—and finds a useful analogy in China's massive use of unskilled labor in civil engineering. ("The pay is good, there is sporting rivalry between work gangs, and when the workers return, they are the heroes of their village, telling evening after evening 'how we built the dam' stories.")

The reign of Zoser—the first king of the Third Dynasty, buried in the first of the pyramids—marked the unification of Upper and Lower Egypt. "The stage had been set for the next phase in the development of society. . . . Centralization of power and administration became the key object. It was achieved by the ingenious device of creating a large communal task.

"That the pyramid was chosen is not surprising. Heaping up an impressive man-made mountain is the simplest and most basic great communal task that can be imagined. All that is required for its achievement is a worthwhile reason. The existing Osiris cult easily lent itself to an interpretation in which the ascent of the dead pharaoh to the sun was of paramount importance for the afterlife of every member of the community." (It would appear also that mountains—even quite small ones—have had about the same deep and powerful significance for dwellers in the Middle-Eastern flatlands that "the frontier" has had for Americans. They feature very prominently in the great religions of those parts.)

Once Egypt had embarked on this great common enterprise, says Dr. Mendelssohn, the government-funded work-force was kept continuously occupied by phasing each new pyramid into the tailing-off period of the last one, whether or not a pharaoh needed burying. (Dr. Mendelssohn argues convincingly that the third pyramid was already half built when the nearly completed second one collapsed; the third pyramid's "bent" sides and other peculiarities are evidence of rethinking in midcourse by the alarmed engineers.) By the end of the century, a collection of tribes had been converted into a unified nation, which could then go on to do more noteworthy things.

Technology at a Crossroads



For 50 years the U.S. has been preparing a cadre of "high" technologists—doctorate graduates able to conceive new theories and new applications. For the entire period annual growth rates of doctorate populations have ranged from 15 per cent for engineering to 8 per cent in the natural sciences. But now suddenly the U.S. is no longer interested in "high" technology; priorities have shifted. Hence Professor Paul A. Samuelson's paraphrase of the old freshman welcome to M.I.T. when addressing a group of alumni this spring: "Look to your right; look to your left. One of you won't be here next year."

Science and technology have reached a point of change. Their future is not necessarily either darker or brighter; but it is radically divergent from the past. For scientists and engineers—both employed and unemployed, for educational institutions and their new graduates, for would-be government contractors, for technically based industry, even for defense-related technology . . . for all of these, and more, it's a new ball game.

Fresh from the government's defeat on the S.S.T., Secor D. Browne, Chairman of the Civil Aeronautics Board, told a seminar of M.I.T. alumni this spring that "disenchantment with technology" is "the chief disease of our time." And Paul A. Samuelson, Professor of Economics at M.I.T., listed "seven strikes against the professional who is now clinging precariously to a scientific or engineering job."

But for every pessimist at the seminar there was an optimist. Jerome B. Wiesner, M.I.T. Provost who becomes President of the Institute in July: We are involved in a process of moving toward great abundance for many; science and engineering must be used to help us reach this goal, for only technology can make man more productive.

But how to use this power effectively? The Engineering Manpower Commission of Engineers Joint Council, said its Director, John D. Alden, has solid evidence that the average engineering graduate in the Class of 1970 had no real difficulty finding a job a year ago; and salary offers to the Class of 1971 are higher than they were then. Labor Department statistics predict continued annual increases in the employment of engineers, Mr. Alden said.

Can all these views yield a single image? Read on:

A New Political Strategy for Science

A new and very different critical eye is now cast on technology in Washington and even throughout the country, said Harvey M. Sapolsky, Associate Professor of Political Science at M.I.T. The day when Congress will write out a single large check for the realization of a technological promise is now past, and the difference represents a new watershed which scientists and engineers need to understand—and exploit if they can.

At least three things are happening to the environment out of which can come public support of science, Professor Sapolsky told the seminar. Cost overruns, schedule slippages, and all the issues embodied in "technology assessment" are suddenly public, political concerns. The growing prejudice against what is popularly called the "military-industrial complex" is simply another way of voting against all kinds of large-scale commitments. And everyone—people, Congress, and Executive—is moving away from defense, toward non defense commitments. For engineers and scientists these developments create a wholly new environment:

◇ Technology is no longer the unquestioned panacea for the problems of the day. Consider any of the now urgent social needs: transportation, environment, urban problems, medical care; it is easily argued that these cannot be solved by new technology alone. Indeed, said Professor Sapolsky, there is no consensus "of what constitutes the problem or that technology is a relevant or adequate solution."

◇ There has been no organized pressure group against technology for defense; "the Russians have no lobby in Washington," said Professor Sapolsky. But when you tackle today's domestic problems, you can expect to find all kinds of hostility—from the highway lobby on mass transportation, from the labor unions on industrialized housing, even from neighborhoods on urban renewal.

◇ Selling new technology to the Department of Defense is relatively simple: there is one buyer writing specifications and making decisions. Not so with transportation technology, for example; there are all sorts of decision makers, including several federal agencies, several state agencies, professional societies, municipal agencies, lawmakers at

all three levels, and institutions and quasi-government groups.

How shall scientists and engineers respond to this new political environment? Perhaps they cannot really do so. "No strategy for seeking new resources for socially oriented technology is likely to be very successful—in the conventional terms of success—in the near future," Professor Sapolsky said. Grants will be smaller and harder to win.

Three suggestions: try to avoid the traditional political arenas; look for new ways to state the case; think not in terms of great unified systems but of small, flexible plans which can be parts of the bigger systems we seem to need but do not want to buy.

No Comfort in Economics

The economic environment of today's technology is just as different, just as important, and perhaps even more discouraging than the political environment, Lester C. Thurow, Professor of Economics, told the alumni this spring. The prognosis is bad, short- or long-term.

In the short run, said Professor Thurow, you cannot hide your head ostrich-like in the sand: we are in a period of recession with a national unemployment rate of about 6 per cent and no reason to expect a sudden change. As if that were not bad enough, consider that this recession has one very special characteristic: while the usual recession most affects workers at the bottom of the scale of skill and pay, this one selects its victims differently. Today's unemployed is likely to be a professional with highly developed, inflexible skills whose salary experience is very good. It's far more difficult for an unemployed $15,000-a-year specialist than for a $2.50-an-hour laborer to be absorbed back into a slowed-down economy.

Professor Thurow's long-run view is little better. "There is nothing conceivable in the future economy with such a high demand for engineering per dollar of product as defense and space," he declared.

The typical goal of high technology is to do something that has never been done before. But when we come to attacking the problems on which Americans are now putting highest priority, we tend to give a different emphasis. We simply want to do more of what we've already done before, and do it cheaper. If defense problems require "high" technology, today's civilian problems tend to require "low" technology, said Professor Thurow.

One ray of hope. The fact that conventional warfare is no longer politically possible is forcing the Department of Defense to turn to more sophisticated weapons systems. Even the budget now before the Congress anticipates large increases in electronic procurement, he noted.

An Historical Perspective

Jerome B. Wiesner, M.I.T.'s President-Elect, can hardly ignore such trends as these, for they force upon every engineering school the question of what to do with its resources and talent. "We as an institution are terribly in need of some judgments about the future to guide our own development," he admitted to the alumni.

Nor is he a stranger to the problems, Dr. Wiesner said. He surprised many in his audience by revealing that the same questions were before him when, as President John F. Kennedy's science adviser, Dr. Wiesner was developing national scientific priorities in the early 1960's.

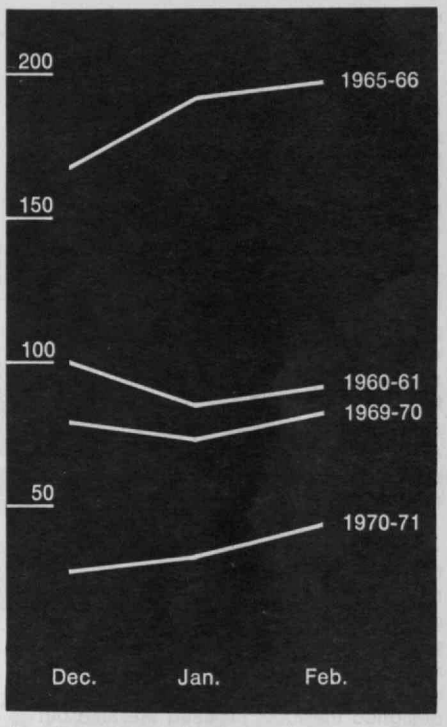
Their discussions of the space program, said Dr. Wiesner, convinced President Kennedy's administration that serious problems might soon exist in the scientific community. The U.S. space program (even then recognized as an unproductive use of scientific resources, yet necessary for its impact on international politics) simply postponed their appearance.

The Kennedy administration was considering two questions: how to divert research and development to current domestic problems; and how to encourage many mature industries in the U.S. to use research and development more effectively to advance their opportunities and enhance their profitability.

Both problems turned out to be intractable. "We simply could not acquire useful 'conversion' plans," said Dr. Wiesner, and there was industry and labor resistance to larger research and development investments. Indeed, said Dr. Wiesner, citing arguments which J. Herbert Hollomon, former President of the University of Oklahoma, will make in the July/August issue of this magazine, America's declining position in international technology may possibly be traced to industry's failure to invest in research and development.

Today, Dr. Wiesner said, American industrial investment in research and development per dollar of product is 30 per cent lower than Japan's. Is it possible, he asked, that our heavy investment in military research in the 1950's and 1960's created an economy of scarcity in which research and development was literally priced out of the industrial market?

Even in the early 1960's, said Dr. Wiesner, "I had a feeling that I was the last science adviser who could run with a free-flowing budget in a society being prepared to support whatever bright scientists could envision."



Deutsch, Shea and Evans, Inc., a New York manpower advertising agency, maintains an index of demand for scientists and engineers based on the volume of recruiting advertising in a selected group of technical journals and newspapers. The figures on the chart above lead the analyzers to conclude that "the downturn in technical employment has bottomed out;" their prediction is for the demand picture "to fluctuate near the current level through the summer and—if the economy maintains its present impetus—to begin to move upward in the autumn." (Data: Deutsch, Shea & Evans, Inc.)

Trauma by the Swimming Pool

If you are clinging precariously to a job in science or engineering today, there are fully seven strikes against you. Listing them, Paul A. Samuelson, Professor of Economics, agreed that the alumni in his audience who came to hear about "blood, sweat, and tears" would not be disappointed.

◇ It is a disastrous coincidence—nothing more—that the wind-down of the Vietnamese war and its accompanying economic malaise coincides with the wind-down of the U.S. space program. Either one alone would have been enough to imperil the careers of a number of engineers and scientists.

◇ Still a third coincidental effect is the wind-down of government support for research and development. "It is harder today to obtain a government grant for desulfurization research than it was in the era of space research commitments." Professor Samuelson said.

◇ We have been devoting our engineering to "high" technology while our competitors have been focusing on "useful" technology; our industry is now behind, suddenly unable to compete in manufacturing such technology-based products as textiles and consumer electronics. Another way of saying it: "The dollar is now overvalued on the international market," said Professor Samuelson.

◇ Engineers are the victim of what Professor Samuelson called the "acceleration principle." While the profession was growing and the system accelerating, engineering begot more engineering. But now it is decelerating: one engineer out of work means that the engineers who designed the tools he used are also out of work.

◇ Scientists and engineers are victims of the supply-and-demand cycle; with the U.S. in the grip of an "anti-science" mood, people are "turning away from everything analytical," Professor Samuelson said.

◇ For 20 years after World War II no one worried about vocational education and everyone went to four-year colleges and universities. Now the supply of college graduates is simply too big.

◇ The engineer's "lifetime dynamics" are unusual; there is a premium on youth. Even while companies are hiring new graduate engineers they are laying off their 20-year men, or switching them into management. The laid-off 20-year-man, having developed a tremendous economic dependence on his job to support his house, swimming pool, and private school tuition, faces the trauma of a downward adjustment.

For the unemployed engineer who reasonably asks about the coincidence which brings all these things against him at once, Professor Samuelson has plenty of sympathy—but no answers, and no job. "It couldn't happen to a nicer bunch of guys," he said.

Employment: "Crisis" in Physics...

The sources of the physicists' manpower crisis—according to one report 40 per cent of physicists now seeking traditional positions in teaching or research are unable to find them—are made clear in data assembled by Lee Grodzins, Professor of Physics at M.I.T., who chairs the American Physical Society's Economic Concerns Committee. While federal funding for research in physics suddenly reached a plateau (as measured in constant dollars) in 1962, the number of Ph.D. physics graduates continued to climb and the research funding per physicist began its inexorable decline.

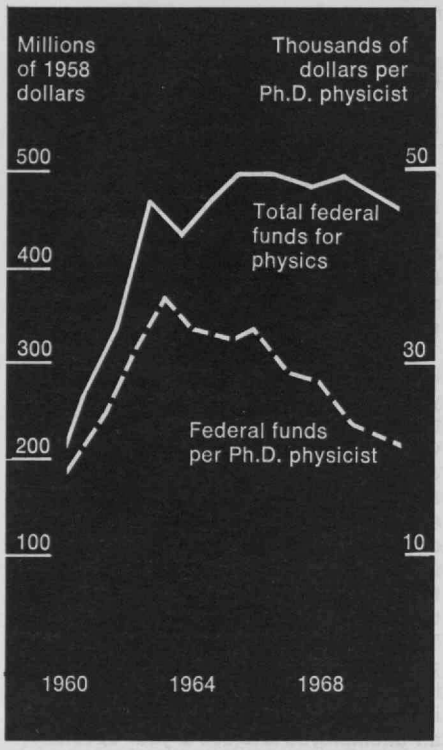
Perhaps more thoroughly than any other scientific group, physicists have studied their present and future employment prospects—with results which have yielded concern, alarm, and even despair.

The analysis has been the responsibility of Lee Grodzins, Professor of Physics at M.I.T., as Chairman of the American Physical Society's Economic Concerns Committee. The principal conclusion, as reported to alumni attending the seminar: in the five years between 1969 and 1974 (when about 1,500 Ph.D. physicists will graduate each year), the supply of doctorate physicists will be between 3,500 and 5,000 in excess of demand, which is declining in consequence of reduced federal support and because of the general economic downturn. If the surplus physicists who want to be absorbed into physics-related work cannot be accommodated before 1974 they will simply remain on the waiting list and the log-jam will continue, despite the fact that the supply of post-1974 graduates will be approximately equal to the demand by that time.

The current unemployment rate among physicists seems low—about 2 per cent, Professor Grodzins told the alumni seminar; but this is not a true measure of the problem, because physicists are ingenious at finding nonphysics employment and so—although driving taxis—do not show up as unemployed. "We estimate that about 1,500 Ph.D. physicists have now been displaced out of the physics community in this country," he said. "The situation is deteriorating, the percentages going abroad, leaving physics, and of unemployed are all increasing."

To emphasize his pessimism, Professor Grodzins cites what he calls "the flywheel effect." Physicists were in short supply as recently as 1967, and the employment crisis was not really visible—though predicted by some—until 1969. By then the physicists who will receive their doctorates in the first half of the 1970's were already started in school, their choices made, and faculty to teach them had been hired. When the demand tapers off, there's a five-year (or more) time delay before the supply can respond. And—what's worse—when the supply does begin to respond, that will signal a decrease in physics enrollments and therefore a decreasing demand for physicists on university faculties.

Professor Grodzins' findings—and their own sense of outrage—are the inspiration for an informal organization of younger faculty and their students which



formed itself during a conference on graduate teaching sponsored by the Commission on College Physics at Arden House last winter. This "Arden House Group" surfaced at the spring meeting of the American Physical Society just a week after the M.I.T. seminar for alumni, declaring that there is a crisis threatening all of physics, that the current problems are in no sense a "temporary imbalance" but a major change in the condition of the profession—from immaturity to maturity—which requires "a severe readjustment of our outlook if we are not to collapse into chaos."

The Arden House Group's proposal is to curtail the education of physicists by insisting that each university physics department guarantee a postdoctoral post to each of its Ph.D. graduates for a minimum of five years at a salary at least twice his pre-Ph.D. support—at best "meager financial remuneration."

Professor Grodzins' committee is not prepared for such a drastic proposal. Alarmist views—even the Economic Con-

cerns Committee report itself—tend to give "a highly distorted picture of our profession which has been and will continue to be strong," he told the alumni.

"The top students are still making it to the top," he said, and any present policy which discourages such young people from entering the field is "shortsighted and probably counterproductive. . . . We expect that a physics training, carried through with the broadest of attitudes and the widest of visions . . . will better prepare a man for a future scientific career than would any alternative training."

That rosy view was hardly popular at this spring's meeting of the American Physical Society, filled with rumors about physics students who will graduate this month returning empty-handed from countless job interviews. Professor Grodzins himself cited the problems of 48 Ph.D.'s in physics who had six-month notice that their employment would terminate when N.A.S.A.'s Electronics Research Center in Cambridge ceased operations in July, 1970; five months later, in November, 19 remained unemployed. Another measure of physics' "painful crisis of numbers and funds" was the A.P.S. meeting registration: at the end of the first day in 1971, down 20 per cent from the same meeting, same time, same place (Washington, D.C.) one year earlier.

Electrical Engineers

While most physicists are employed in universities and laboratories, where turnover is likely to be slow, electrical engineers are typically in industry where turnover is high. The result is that though the unemployment rate at any given moment may be high among electrical engineers, the pain is rather less: the pool of unemployed is in constant motion, job takers leaving while job wanters enter.

Some 15 per cent of Boston-area electrical engineers are unemployed or underemployed, according to a survey of the Boston Section of the Institute of Electrical and Electronics Engineers reported by Paul L. Penfield, Jr., Professor of Electrical Engineering. But remember, he cautioned his audience, that the pool is not stationary; what the figures really mean is that more people are taking longer to find new jobs. There are not, he opines, many cases of "hard-core" unemployment among electrical engineers.

But what of the future? The U.S. labor force is rising in numbers faster than the U.S. population; the professional and technical labor force is rising faster still; and the number of engineers is increasing most rapidly of all. Today, according to Professor Penfield's figures, one of every 200 U.S. workers is an electrical engineer; hence his key question: "Should society really support that many electrical engineers?"

"Relax, pal, you can't believe everything you read in the newspaper," says the President in this acrid editorial cartoon from the Boston Globe. *Paul L. Penfield, Jr., Professor of Electrical Engineering at M.I.T., had something of the same message for an M.I.T. seminar this spring, based on a survey of Boston-area members of the Institute of Electrical and Electronics Engineers: some 15 per cent of their number are currently unemployed or under-employed, but it is a shifting minority with few "hard-core" members, he said.*

. . . and Engineers in General

John D. Alden, Director of Manpower Studies at Engineers' Joint Council, took a brighter view. He admitted that a surplus of doctorate engineers—the fastest-growing segment of engineering—now exists. But he denied that more engineers than other professional people are job-hunting now, and he joined other seminar speakers in noting that the rate of production of Ph.D. engineers must inevitably be reduced, else there be more doctorates than babies in the U.S.

Current indicators are confusing. The supply and demand figures for engineers assembled by Mr. Alden's Engineering Manpower Commission during the last decade have never been in balance; companies have always reported their intention to hire more new engineers than the colleges would graduate. From now until 1980, according to current U.S. Department of Labor projections, the average annual demand for engineers will be over 50,000, a figure higher—as heretofore—than the likely number of engineering graduates. Only the outlook for 1971 is more ominous: this spring, for the only time between 1960 and 1980—stated demand—33,000, according to the Engineering Manpower Commission—and supply will be about equal.

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Tech-Crostic
David L. and Judith G. Holt

Of Alchemy and Rue

■	■	■	■	■	■	■	V 1	■	D 2	F 3	R 4	C 5	N 6	O 7	Q 8	A 9	■	D 10	L 11	F 12
P 13	E 14	M 15	■	W 16	A 17	J 18	U 19	I 20	■	Q 21	Y 22	■	B 23	G 24	F 25	D 26	S 27	A 28
E 29	H 30	T 31	W 32	■	F 33	P 34	I 35	G 36	■	J 37	T 38	Z 39	■	X 40	C 41	K 42	D 43	N 44
F 45	R 46	E 47	■	H 48	A 49	■	P 50	C 51	S 52	F 53	N 54	E 55	W 56	Y 57	■	U 58	X 59	■
Q 60	■	I 61	U 62	K 63	Q 64	A 65	W 66	■	Y 67	P 68	■	B 69	O 70	M 71	F 72	K 73	X 74	■
D 75	F 76	S 77	B 78	I 79	P 80	V 81	U 82	■	Q 83	A 84	■	I 85	E 86	Q 87	M 88	F 89	■	A 90
L 91	E 92	K 93	N 94	G 95	O 96	B 97	■	L 98	D 99	P 100	W 101	L 102	■	R 103	A 104	T 105	V 106	H 107
■	V 108	X 109	■	S 110	■	C 111	G 112	Q 113	F 114	X 115	N 116	V 117	D 118	Z 119	■	M 120	S 121	H 122
K 123	A 124	■	G 125	W 126	I 127	R 128	E 129	■	T 130	V 131	F 132	O 133	D 134	R 135	L 136	U 137	I 138	Q 139
B 140	A 141	■	H 142	Y 143	Z 144	N 145	D 146	J 147	■	E 148	W 149	O 150	C 151	Q 152	N 153	F 154	W 155	■
V 156	T 157	■	I 158	B 159	E 160	T 161	Q 162	F 163	■	L 164	Y 165	P 166	D 167	■	V 168	Z 169	■	X 170
■	F 171	M 172	C 173	Z 174	N 175	A 176	■	U 177	V 178	E 179	Z 180	D 181	J 182	■	■	■	■	■

Use the definitions at the right to help define the words to which they refer; then enter the appropriate letters in the diagram to complete a quotation from a scientific work. The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate the ends of words; when there is no black square at the right end of the diagram, the word continues on the next line.

The correct solution to this Tech-Crostic will appear in the July/August issue of *Technology Review*.

David L. Holt is Assistant Professor of Metallurgy at M.I.T. He will welcome reader's comments; address him in care of *Technology Review*, Room E19-430, M.I.T., Cambridge, Mass. 02139.

A. Variety of pyroxene.

141 90 17 104 84 49 65 9 28
176 124

B. Terrified.

69 97 159 23 78 140

C. Pertaining to a genus of fruit-bearing trees and shrubs of the rue family.

111 173 51 41 5 151

D. The growing of plants in an aqueous solution instead of soil.

99 167 10 134 118 2 26 181 146
75 43

E. Compound with sugar.

55 29 14 148 86 92 129 160 179
47

F. The pyramids of Egypt is one (3 words, followed by Word W).

25 3 132 53 45 33 72 154 114
163 89 171 76 12

G. Raise.

36 112 95 24 125

H. Fungus disease of cereal grains.

122 142 107 48 30

I. Caused by an implanted morbific virus.

138 61 35 20 127 85 79 158

J. Tinge.

37 18 147 182

K. Compassion; clemency.

63 42 123 93 73

L. Heretofore.

11 91 102 136 164 98

M. Fabric woven with an appearance of diagonal lines or ribs.

15 120 88 71 172

N. Alchemists' "universal solvent."

145 6 94 153 175 44 54 116

O. Substance of the achromatic fibrous network of a cell nucleus.

70 7 96 133 150

P. Cleavable.

68 100 80 50 34 166 13

Q. Denial; renunciation.

8 64 139 87 162 60 152 21 83
113

R. Bowls, Italian style.

103 135 4 46 128

S. Large grazing farm.

52 110 77 27 121

T. To be fixed within.

105 161 38 31 157 130

U. The most electropositive of the elements.

19 177 82 58 62 137

V. Substance formed by the body to neutralize a particular poison.

1 106 168 117 81 156 178 108 131

W. Two words, see Word F.

155 126 56 16 149 66 101 32

X. To yoke or harness.

115 59 74 40 170 109

Y. Front ends; nozzles; spouts.

165 67 22 143 57

Z. One haploid set of chromosomes with the genes they contain.

174 180 119 169 144 39

Puzzle Corner
Allan J. Gottlieb

Nine Men Among the Indians

Unfortunately, one portion of the manuscript for this month's column was lost—through no fault of the author's. All the "Better Late Than Never" references, the lists of names from whom solutions have been reveived (the "Also solved by . . ." entries), and several of the credits for problems are gone forever. *The Review* apologizes.

Problems

Someone sent in the following, intended for our mathematical bridge fans:

36 If you are playing South, with clubs distributed as shown:
North
x, x, x
South
Q, J, 9, x, x,x
(the location of ♣ A, ♣K, ♣ 10, and ♣ x being unknown), how should the suit be played to minimize the loss. You are in your hand with no way of reaching dummy.)

Someone else, now unidentified, sent in the following:

37 A pipe can fill a tank in A hours, and the drain can empty it in B hours. If both are left on at the same time, it takes C hours to fill the tank. Show that there are an infinite number of *integers* A, B, and C which satisfy this problem; and find them.

A number theory problem from R. C. Krulish:

38 It is not difficult to prove that $(x^n - x)/n$ is an integer when n is a prime number. (To avoid bickering, let x and n be greater than 1.) Can someone prove, or disprove, that if n is not prime, $(2^n - 2)/n$ cannot be an integer?

Douglas J. Hoylman sends a problem he found while teaching linear algebra:

39 Take an arithmetic progression of mn terms and form it into an mxn matrix by making the first n terms the first row, the next n terms the second row, and so on. What is the rank of this matrix?

Here the last problem for this month, from James R. Bledsoe:

40 Nine men were captured by a strange tribe. All were seated in a straight line. The tribe always served a certain potion to its captives, with every seventh cup containing a deadly poison, and they always served from left to right, continuing from the last victim. They continued serving in this way until all but one prisoner died. They never killed the last man. If you knew this, which position—starting from the left—would you choose?

Speed Problem

Here is a geometrical quickie from Ermanno Signorelli:

SD14 Consider a rectangle with sides a and b, each of arbitrary length, with $a \neq b$. Inscribe five—and only five—triangles in the rectangle, each triangle having two—and only two—sides wholly in common with two other triangles. Identify the positions of the five triangles if the ratio of their areas is 4:5:6:7:8.

Solutions

21 Given the following show how South can complete the contract:

	♠ 5 ♥ Q 2 ♦ A K J 9 8 4 3 ♣ J 9 4	
♠ 8 3 ♥ K J 10 9 8 7 6 3 ♦ 7 2 ♣ 7		♠ J 7 4 ♥ 5 ♦ Q 10 5 ♣ K Q 10 8 6 3
	♠ A K Q 10 9 6 2 ♥ A 4 ♦ 6 ♣ A 5 2	

The bidding, North and South being vulnerable:

South	West	North	East
1 spade	4 hearts	5 diamonds	pass
6 spades	pass	pass	pass

West's lead is ♣ 7.

Because "your girl friend likes to see problems solved jointly by husbands and wives," writes Burt Barnow, he and his wife Renee tackled the problem together. Their solution:
South must take the opening club lead in his hand with the ♣ A. He then draws three rounds of trumps with the ♠ A, ♠ K, and ♠ Q (pitching two clubs from dummy). South then leads his ♦ 6 to the dummy's ♦ A. He then leads ♦ K and pitches the ♥ A (!) from his hand. He then leads a third diamond from the dummy and ruffs in his hand. He then leads his ♥ 4 from his hand. If East plays the ♥ K, he is forced to return a heart to dummy's ♥ Q, where there are two good diamonds; if East does not play the ♥ K the dummy's ♥ Q takes the trick. In either case, declarer pitches his two remaining clubs on the two good diamonds in the dummy.
Burt notes that "if my memory is good, you may remember that I was a hall chairman in Baker House at the same time you were." I do; and he was indeed.

22 Show that the series
$1! + 2! + 3! + \ldots + k!$
is asymptotic as $k \to \infty$ to the sum of the last two terms.

The following is from Richard Fistow:
Let

$$s_k = \sum_{t=1}^{k} i!.$$

Then we are asked to show

$$\lim_{k\to\infty} s_k/[(k-1)! + k!] = 1. \quad (1)$$

Since (if $k > 2$) $s_k = s_{k-2} + (k-1)! + k!$, this reduces to

$$\lim_{k\to\infty} s_{k-2}/[(k-1)! + k!] + [(k-1)! + k!]/[(k-1)! + k!] = 1, \quad (2)$$

or

$$\lim_{k\to\infty} s_{k-2}/[(k-1)! + k!] = 0. \quad (3)$$

Now, for $k > 2$ s_{k-2} is the sum of $(k-2)$ terms, the largest of which is $(k-2)!$; so $s_{k-2} \leq (k-2)(k-2)!$.
This allows us to deduce

$$0 \leq s_{k-2}/[(k-1)! + k!] \leq (k-2)(k-2)!/[(k-1)! + k!] = (k-2)/[(k-1) + k(k-1)] = (k-2)/(k^2-1). \quad (4)$$

Since the last expression clearly goes to zero as k approaches infinity (an easy proof is to replace k by a continuous variable x and take the limit as x approaches infinity by l'Hopital's Rule), this proves line (3) and completes the solution.

23 From each pound of water passing through a hydraulic turbine we can get more and more energy as we increase the pressure head on the water. It is proposed to place a turbine at the bottom of a tower so high that the energy obtained from each pound of water, when converted to electricity by a generator run by the turbine, will be sufficient to electrolyze that pound of water. The resulting gas mixture, being lighter than air, may rise through an adjoining shaft (wrapped in balloons of infinitesimal weight and infinite stretch, if this idea will help) to the top of the tower, where they may be ignited to reform water, condensed, and returned down the tower. The fact that units in the system are not 100 per cent efficient will not prevent operation, as the tower may be made higher than the theoretical height, pro-

ducing enough additional power to offset losses. But no perpetual-motion system is economic unless power can be drawn from it. This can be done by making the tower still higher than necessary to electrolyze the water and offset losses; from the lifting effect of the rising gases; from the heat generated by the burning gases; and by use of the superheated steam formed by the combustion to power a turbine. Aside from possible *practical* difficulties (such as the height of the tower):

1. Will the system run as described?
2. If so, does it constitute perpetual motion; or, if not, from what source does the energy come?
3. If it would not run, point out any fallacy in the reasoning above.

Stephen S. Flaum set my mind to rest; perpetual motion fails again:

The answer to the perpetual motion problem is that the work needed to expand the hydrogen and oxygen is at least equal to the energy developed by the turbine; the fact that the water is electrolyzed does not significantly change the problem from one in which two pistons are moved away from one another inside a cylinder, creating a vacuum between them. In both cases a pressure is exerted through a volume. The machine will not run. Assuming that the water is of negligible volume, that W pounds of water are being used, that the air is of constant density ρ, and that the air stops at the top of the column whose height is H, then the energy developed by the turbine is given by WH, and the weight of air which must be displaced must equal the weight of the water W. If the volume of air is V,

$V = W$, or $V = W/\rho$.

The work done in expanding the air is the volume through which the air is expanded times the pressure:

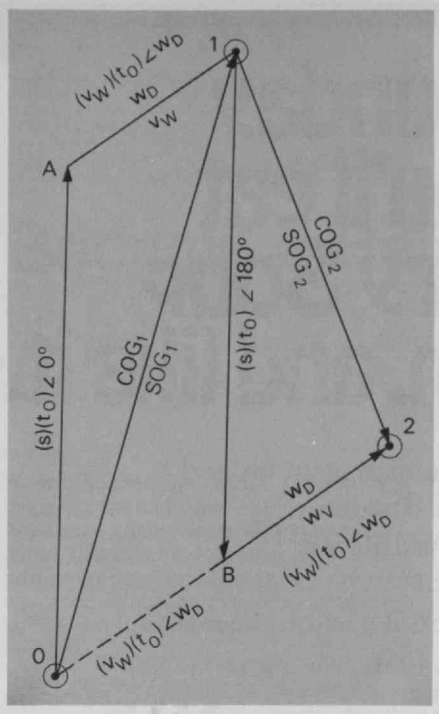
Work $= W/\rho \times H\rho = WH$.

This the same as the work developed by the turbine. Actually, of course, my assumptions about the characteristics of the air are not strictly correct, but the same result could be obtained (with considerably more work) by finding

$$\int_{h=0}^{h=H} Pdv.$$

24 An airplane pilot flies a triangular course, flying first due north for a time t_0, then due south for the same time t_0, and finally returning by a straight line to his starting point. The course is triangular because of a wind of unknown direction and velocity V_W. Assuming the pilot has a stop watch and an air speed indicator which shows his speed relative to the air, and he maintains his air speed constant, how much can he determine the direction and velocity of the wind?

I am not an expert on navigation. There is some disagreement concerning the answer to this problem. I mentioned some of this uncertainty in the "lost" manuscript but now can only print this solution, from Dexter R. Wheeler,



which represents one side of the argument; Mr. Wheeler says it "is really a simple navigation problem"; the standard technique, he says, is to consider the effects of the vehicle's engine and the wind separately:

From starting point 0 construct a course line bearing 000° (north) to point A; the length of this vector represents distance and is equal to air speed S multiplied by time t_0. From A draw an arbitrary vector representing wind direction W_D and wind velocity V_W to point 1; the length of this vector represents distance moved due to wind and is equal to velocity V_W multiplied by time t_0, and the vector is oriented with the direction of the wind W_D. The resultant vector $\vec{01}$ represents the actual course and speed made good over the ground. From point 1 construct a new course line bearing 180° (south) to point B; the length of this vector represents distance and is equal to air speed S multiplied by time t_0, and it is parallel to and equal to $\vec{0A}$. From B construct vector $\vec{B2}$ parallel to and equal to vector $\vec{A1}$, since the same wind direction and velocity act upon the plane on course from 1 to B as did from 0 to A. The resultant vector $\vec{12}$ represents the actual course and speed made good over the ground on this day. From point 2, the plane flies back to point 0. The pilot is then heading directly into the wind and so wind direction is determined as plane heading minus 180°. From point 2 to point 0 the plane's speed over the ground is obviously $S - V_W$. The distance to be travelled is $2V_W t_0$, and the time to return t_r is measured by stopwatch. Plugging these values into the general speed-time-distance equation gives $S - V_W = 2V_W t_0/t_r$, and—solving for wind velocity, $V_W = s/(2t_0/t_r) + 1$.

25 Suppose that a football team scores only touchdowns and points-after-touchdown—i.e., that all scores are either 6 or 7 points. Then 12, 13, and 14, for examples, are possible final scores, but 11 and 15 are not. What is the highest unattainable score? In "generalized" football, the only possible scores are a and b, both integers being greater than 1. Under what conditions is there a maximum attainable total score, and what is it?

Generalized football has been put to rest by the following solution from Robert L. Bishop; now if Namath's wrist will heal, next fall should be quite enjoyable:

There is a maximum unattainable score when a and b are relative primes—i.e., when their greatest common divisor is one. If the g.c.d. were two or more, any score not divisible by that number would obviously be unattainable. When a maximum unattainable score does exist, it equals $ab - a - b$; e.g., 29 when $a = 6$ and $b = 7$.

My proof (devised with the casual but vital help of my colleague, R. M. Solow) makes use of the theorem (which can be proved, though I merely assert it here) that there exist two linear combinations of the relative primes a and b that involve only positive integers, with $m < b$, $n < a$, $s < b$, and $t < a$:

$$ma - nb = 1, \quad (1)$$

$$-sa + tb = 1. \quad (2)$$

Let x be the maximum unattainable score. The next higher score, being attainable, may then be expressed in terms of some non-negative integers, h and k:

$$x + 1 = ha + kb. \quad (3)$$

If we subtract first (1) and then (2),

$$x = (h - m)a + (k + n)b,$$

$$x = (h + s)a + (k - t)b.$$

The unattainability of x must now be reflected in the fact that $h - m < 0$ and $k - t < 0$. Moreover, the *largest* values of h and k for which that will be true are $h = m - 1$ and $k = t - 1$. Therefore, by substitution in (3), we get:

$$x = (m - 1)a + (t - 1)b - 1. \quad (4)$$

Subtracting (2) from (1) gives:

$$(m + s)a = (n + t)b.$$

Furthermore, since $m + s < 2b$ and $n + t < 2a$, and since a and b are relative primes, the only integer solutions are such that $a = n + t$ and $b = m + s$. Now, by substituting $s = b - m$ in (2), we get:

$$-(b - m)a + tb = 1$$

$$ma + tb - 1 = ab$$

$$(m - 1)a + (t - 1)b - 1 = ab - a - b.$$

Therefore, from (4),

$$x = ab - a - b.$$

Allan J. Gottlieb writes from the Department of Mathematics, Brandeis University, Waltham, Mass., 02154, send problems and solutions to him there. Mr. Gottlieb studied mathematics at M.I.T. with the Class of 1967, and he is now pursuing work toward an advanced degree.

"On That Day I Became a Believer"

On the True Status of Dowsing

To the Editor:
Robert C. Cowen, in his article "Is Your Mind Closed to E.S.P.?" (*March, pp. 6-7*) is equivocal on the subject of dowsing; he avoids taking a final conclusion himself.

I take exception to the phrase, "the legend of Henry Gross." I have known Henry Gross for a long time. His dowsing record is one of fact, not legend. Indeed, I have recently heard that Mr. Gross is still receiving good money from hard-headed businessmen for the practice of his skill.

Mr. Cowen's comments on "believers and critics" are not pertinent. Dowsing is not dependent on the "belief" of anyone. Dowsing has been established for some time as a fact of human experience. Students of the process are now concerned about its nature and about the conditions under which the faculty of dowsing can become operative.

It is unfortunate that Mr. Cowen should report on the tests on dowsing by the British Ministry of Defense with the implication that these tests were competent and adequate to support the conclusions about dowsing given out.

The tests can be questioned about their details from many angles, most of which would call for knowledge of the dowsing process, and such examination of them would call for much space and time. For a dowsing layman, the status of the tests can best be summed up by the following hypothetical question.

How would a member of the faculty of M.I.T. react to an account of tests and conclusions if these tests were set up by someone with no special familiarity with the discipline or subject that the faculty member had as his specialty, and these tests concluded that this discipline had no value? That is what happened in England. An outsider stepped into a field in which he was ignorant. The only thing proven was that, on a certain day, under certain conditions, a random group of dowsers were unable to find a certain type of object.

Any informed student of dowsing could have predicted that result in advance if the program had been outlined to him. I have seen similar tests with similar results. There is developing a positive expertise in dowsing. The conditions under which dowsing can expect to produce a successful find are fairly well established by now.

Raymond C. Willey
Danville, Vt.

The writer is Secretary and Editor of the American Society of Dowsers, Inc.; his letter "is written under the program of the Society to bring to the public a more realistic idea of dowsing."—Ed.

Notes from a Believer

To the Editor:
I read Robert C. Cowen's article on dowsing with interest, and I suspect your readers may be interested in my experience:

In 1936, while an apprentice, I was sent along with a fitter to a small country village in Aberdeenshire, Scotland. We went to work in a large shooting lodge nearby and were boarded with a couple who lived and worked for the estate.

Our host, Frank, was the general handyman and, as it turned out, the local dowser. As was often the case, there was considerable scorn shown by the fitter and me toward the question of locating water by walking along holding out a twig.

The day came when Frank's services as a dowser were required, and we went along for some fun. Both the fitter and I tried to do exactly as Frank did by cutting a straight piece of gorse twig and, holding each end, bending it into a "U" shape. Frank eventually reached a spot where his twig bent down violently, while our own twigs remained completely static.

When we tried holding a twig between us and holding hands nothing happened, but when Frank held our separate hands while we held the twig between us, the twig bent down with such strength that the bark was stripped off the end of the twig in our hands. Frank had no direct contact with that twig, except that he was in the circle. On that day I became a believer.

Harry Hallwood
Arlington Heights, Ill.

Dowsing and E. S. P.

To the Editor:
I am glad that a test has been made of dowsing, as Mr. Cowen reports in Technology Review, for such was certainly called for. Let me point out, however, that dowsing is not necessarily E.S.P., as Y. Rocard, Professor of the Faculty of Sciences at the University of Paris, emphasizes in his book on the subject *(Le Signal du Sourcier)*; he suggests looking for physiological effects of magnetic fields set up by electrofiltration currents. There is nothing whatsoever of the occult in his approach.

Donald J. Montgomery
East Lansing, Mich.

Professor Montgomery is Professor of Physics and Chairman of the Department of Metallurgy, Mechanics, and Materials Science at Michigan State University.
—Ed.

May Tech-Crostic Solution

For if consciousness is but a neural activity, it should be subject, like any other physical process, to cybernetical analysis. But evidently the phenomenon of consciousness slips through the sieves of cybernetics no less swiftly than it keeps eluding the anatomist's scalpel or the neurophysiologist's electrodes.
—S. L. Jaki, *Brain, Mind, and Computers*

A good way to remember

M.I.T. CHAIR

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TR-71

Institute Review

Choosing the Class of 1975 From 20% Fewer Applicants

Just over 3,800 high school seniors applied for admission to M.I.T. in the Class of 1975 which will enter the Institute next fall. By April 1 just over 1,600 had been notified of their admission, and another 150 were on a waiting list—pending future developments. When the self-sorting processes are finished, Roland B. Greeley, Director of Admissions, hopes the new class will be just under 1,000, 875 men and 120 women. It will contain more girls than ever before, and the number from minority groups—75—will be about the same as in recent classes.

The startling Admissions Office statistic is that M.I.T.'s 3,800 1971 applicants were a full 20 per cent fewer than in 1970. It is one of the largest declines reported in a year of changing college preferences throughout the U.S.

In general, applications for 1971 to private New England colleges were fewer this year—Yale down 16 per cent; Boston University, 18 per cent; Tufts University, 4 per cent; and Harvard, 11 per cent, for example. State universities were mixed—some up, some down (especially by out-of-state students)—while local and community institutions found themselves flooded with applicants.

Why? College admissions officers throughout the country are quick to blame the rising costs of "elite" universities in a period of economic uncertainty—or even recession; and there is talk about the rising quality of local schools and declining concern for the traditional measures of value in higher education.

Not content to rely on such generalities, the M.I.T. Admissions Office sought judgments of high school guidance counselors from throughout the U.S. who have been the Institute's recent guests at the annual Guidance Conferences; in addition to the economic issue, they cited:

◇ The reduced opportunities and job security apparently open to graduates in the sciences and engineering.

◇ A general decline in the drawing power of "prestige" institutions—simply because of a change in students' value systems and, as well, because of the rapidly rising quality of public institutions, including community colleges.

◇ Concern by students—and, perhaps especially, their parents—about the "activist" scene and the urban environment of many "prestige" schools. One Midwestern counselor referred directly to the "turmoil, anti-American feelings, and heavy drug use that predominate" in the East.

◇ The changing interests of young people toward careers more concerned with social and humanistic goals, and their reduced tolerance for academic rigor.

In sum, Professor Greeley concludes that there is suddenly "much more widespread questioning than I expected on the question of whether a 'prestige' college education is worth the cost as measured in money, in hard academic work, and in the problems of living away from home."

M.I.T.'s figures confirm these judgments. When they apply to M.I.T., high school students are asked to indicate the field in which they expect to study—though the admission decision is not based on this information and the student's decision is subject to later change. This year, says Professor Greeley, "there has been a discouragingly high continuation of the swing away from engineering." Of freshmen who registered last fall, 39 per cent listed some branch of engineering as their first choice; of those admitted for 1971 only 30 per cent think they will study engineering. Science is up—the choice of 57 per cent of last year's class to over 63 per cent of this year's admitted group; so is interest in premedical education.

Applications from the South and Midwest are slightly fewer this year; the geographic distribution of the Class of 1975 will be skewed slightly toward the New England and the North Atlantic states compared to its recent predecessors, says Professor Greeley.

Will the quality of the class be lower because M.I.T. had fewer applicants from which to choose? Calculating the average of scores on the five tests of the College Entrance Examination Board from which M.I.T. receives results, the admitted students are three points higher than those in the Class of 1970. But Professor Greeley admits that the selection process this year dipped a little lower than usual into the pool of applicants. He insists that the level of applicants continues to be so high that "the difference will not be detected by teachers of freshmen next fall."

On Evaluating Applications

A plan for markedly increasing faculty participation in the process of choosing new students to enter M.I.T. was tested by the Institute's Admissions Office this spring during the evaluation of applications for the Class of 1975 (*see above*).

Members of the faculty Committee on Undergraduate Admissions and Financial Aid have always been instrumental in determining the "ground rules" under which applications are evaluated, and faculty have often shared informally in the task of reading and evaluating individual applications, the bulk of which was done by members of the Admissions Office staff.

This year it was different for nearly half of the 3,800 applications—including all those from prospective coeds. Responding to requests for greater faculty participation, the Admissions Office established five teams—each consisting of two faculty volunteers and one staff member. To each team went the files—C.E.E.B. scores, interview reports, and recommendations—of 200 male applicants and its share of all the applications from women. The task in each case was to determine the personal and scholastic ratings on the basis of which admission would be offered or denied.

The faculty found the job hard—but interesting. A preliminary study of results shows that there were minor—probably insignificant—differences in the ratings between team- and staff-read applications, says Professor

Roland B. Greeley, Director of Admissions. But more faculty than ever before have come to realize the special qualities and limitations of the preadmission information, says Professor Greeley, and the Committee is now mounting a study of how the information in an applicant's folder actually correlates with what happens after he arrives at M.I.T.

Scholarships and Loans: The Widening Gap

Of the 1,600 applicants who were admitted to M.I.T.'s Class of 1975 (*see above*), some 800 required—according to M.I.T.'s formula for computing need—some kind of financial assistance to enter the Institute.

Because of increases in tuition and room and board charges effective next fall (*see below*), the average student budget, on the basis of which financial needs are computed, will be $400 higher for 1971-72 (up from $4,500 in 1970-71). But the total financial aid available from M.I.T. to the freshman class next year must remain essentially unchanged, according to Jack H. Frailey, '44, Director of Student Aid. Students who need help are being asked to obtain the $400 difference in anticipated expenses by taking loans under the federal Guaranteed Loan Program.

Scholarships and loans for the Class of 1975 will be determined, as usual, on the basis of information submitted by each applicant and his parents to the College Scholarship Service of the College Entrance Examination Board. Applicants who on the basis of this information need financial aid in 1971-72 received the following suggestions and offers from M.I.T.:

◇ If the need was calculated to be $600 or less, it should be filled by income from a term-time job; typically this will require eight to 10 hours of work a week.

◇ The next $400 of need—up to a total of $1,000—should be met by a G.L.P. loan; for students who find such loans unavailable, M.I.T. loans will be made under comparable terms. If a student does not wish to work or simply cannot find a job—freshman jobs may be tighter next year—he'll be asked to take additional G.L.P. loan money.

◇ The next $600 of need—up to a total of $1,600—will be met by a loan from the National Defense Student Loan and the Technology Loan Funds.

◇ Need above $1,600—up to the total budget in the unusual case where a student and his family can make no contribution to his educational expenses—will be met by scholarship grants. No M.I.T. scholarships will go to the Class of 1975 as reward for academic merit.

For applicants from designated minority groups, loan and job awards are limited to $500; scholarship funds are substituted for the remaining self-help loans throughout the schedule above.

Last year, for the Class of 1974, the total self-help threshold was $1,200 rather than $1,600, and the $400 G.L.P. loans were not included. The result was over $800,000 in scholarships and $500,000 of Institute loan funds committed to freshmen during the year just ending. These totals cannot be increased for the Class of 1975, despite the increased expenses which each student must expect next fall; additional funds are simply not available. Whether the widening gap between need and award will affect the number of students who decide to enter M.I.T. next September remains, as this is written, the unanswerable question.

Student Expenses Up 10 Per Cent

Undergraduate and graduate students at M.I.T. must plan on increases of nearly 10 per cent in their expenses next year. To the previously announced tuition increase ($150, to $2,650 per year—see *Technology Review* for October/November, p. 99) have now been added increases in room and board charges in all of the Institute's houses.

Ashdown House dining room, originally scheduled to be closed next year, will be open after all—a decision resulting from a large volume of correspondence and a 1,500-signature petition from residents, faculty, and staff who enjoy its convenient location and congenial atmosphere. Instead, the dining room in Burton House will not reopen when renovations are completed in the House at the end of the summer, and residents there will eat in Ashdown House or in the nearby MacGregor House dining room.

"Commons" meals charges—three meals a day, five days a week—will increase about 7½ per cent next year—from $594 to $639 for the academic year—and there will be a $45 across-the-board increase in room rates (per year) in all Institute houses. Both represent the increasing cost of labor and supplies. In addition, M.I.T.'s operating problems are compounded by slowly decreasing patronage in campus dining rooms. To break even on these "auxiliary" activities next year, an additional "subsidy" charge must be added to dormitory rentals for those who do not elect "commons" meals. Hence the estimate of an overall increase approximating 10 per cent.

Leaving Technology Square

Having accomplished the purposes of its original participation, M.I.T. has sold to its codevelopers—Cabot, Cabot & Forbes Co.—the Institute's interest in Technology Square, the ten-year-old "industrial park" development adjacent to the M.I.T. campus.

Dr. James R. Killian, Jr., '26, Chairman of the M.I.T. Corporation, recalled in making the announcement that the Institute originally joined with C. C. & F. in order—with the city's help—to create a new development on underutilized land which would increase the tax base and employment opportunities in Cambridge and at the same time provide a focus of interests congenial to M.I.T. Those purposes having been realized, and because "M.I.T. is not in the business of continuing such real estate developments," Dr. Killian said, the decision was made to withdraw.

Funds released will be returned to other forms of investment, and Dr. Killian speculated that completion of its involvement in Technology Square will render the Institute "better able to see through a development program of comparable benefit to the City" on the site formerly occupied by the Simplex Wire and Cable Co., purchased last year. Though the Institute's purposes in investing in Technology Square were far broader than the self-interest of realizing income on invested funds, there is evidence that the Institute's return on its ten-year Technology Square financing was excellent.

In his announcement, Dr. Killian noted that Technology Square is now the fourth largest source of property taxes in Cambridge. Before development the site yielded $86,000 annually, and Technology Square now pays more than $580,000 a year.

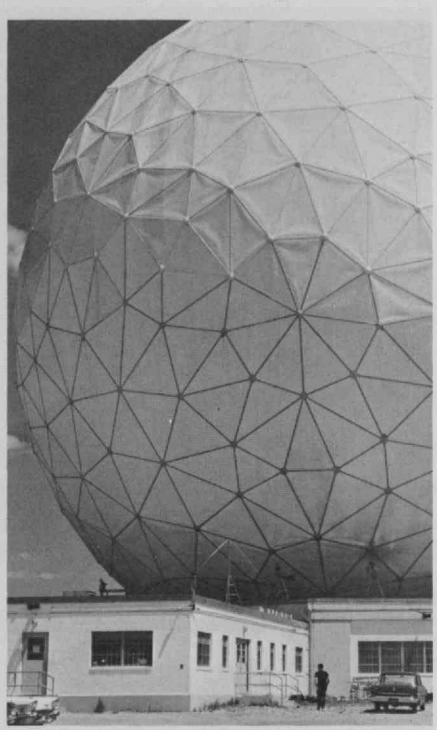
Gerald W. Blakeley, Jr., President of Cabot, Cabot & Forbes, emphasized that M.I.T.'s withdrawal would not affect plans for completing the Technology Square development. Four buildings now on the 14-acre site include more than 550,000 sq. ft. of floor space; two more buildings are presently being planned, Mr. Blakeley said, and the master plan calls for an eventual 1 million sq. ft.

Tribute in Texas

Decanters bearing seals of M.I.T. and the state of Texas and Honorary Citizenship in the city of Dallas were among the tributes to Dr. and Mrs. James R. Killian, Jr. ('26) at a dinner in their honor given by the M.I.T. Club of Dallas on March 15. Dr. Killian retires as Chairman of the M.I.T. Corporation on June 30.

More than 100 alumni, wives, and guests—including administrators of nine Dallas-area colleges and universities—attended the dinner. Dr. Killian, in additional to acknowledging the support of Texas alumni to the Institute throughout the period of his leadership, spoke briefly of the success of Dallas' public television KERA-TV and of its Tager system of closed-circuit television to educational and business institutions. Recalling his participation in the Carnegie Foundation study which originally resulted in establishment of the Corporation for Public Broadcasting, Dr. Killian said that there "has been a very heartening growth in community support" for such activities. "I think television is bound to be educational, whether for good or ill," he declared. The problem is to be sure that sufficient support and channels—including cable television—exist to realize the values of the medium for many different purposes and interests.

The Haystack antenna, designed and built for the U.S. Air Force by Lincoln Laboratory, ranks among the world's best and most versatile radio and radar astronomy centers. Phased out by the Air Force, it has been given to M.I.T. to be operated under the direction of the Northeast Radio Observatory Corp., a 13-institution consortium of which the Institute is a leading member.



The Haystack Observatory Is "Converted" to M.I.T.

The Haystack radar, completed in 1964 and operated from then until July 1, 1970, by Lincoln Laboratory for space communications and other microwave research for the U.S. Air Force, has become property of M.I.T. and is now providing expanding services to the scientific community as the Haystack Observatory under the direction of the Northeast Radio Observatory Corp. (N.E.R.O.C.), a consortium of 13 educational and research institutions in the New England area.

The transition, completed quietly during the last half of 1970, has three-fold significance: it has resulted in one of the five or six foremost radar and radio observatories in the U.S. becoming available for full-time scientific use by astronomers and their students from throughout the country; it makes secure M.I.T.'s place among the leading centers of U.S. astronomy; and it represents one of the first successful transfers of a major scientific project from military to civilian sponsorship under the so-called Mansfield Amendment to the 1970 military budget act in the U.S. Congress.

Under the terms of an agreement between M.I.T. and N.E.R.O.C., Haystack has been operating since July 1, with grants to N.E.R.O.C. totaling over $1 million from the National Science Foundation and National Aeronautics and Space Administration; and there have been additional amounts from some institutional members of N.E.R.O.C. In the last half of 1970, the Observatory was used for 39 research programs by faculty, staff, and students of at least 12 institutions. In addition, the group of Lincoln Laboratory scientists who were using the Haystack facilities for planetary radar astronomy before the transfer have continued their work as members of the M.I.T. staff.

Among projects using Haystack since July have been a number of intercontinental interferometer studies of distant energy sources, some of them extensions of the work, originally performed with Haystack, for which an M.I.T. group this spring won the coveted Rumford Premium of the American Academy of Arts and Sciences (*see "Trend of Affairs"*); research on astrochemistry, to identify and locate sources of interstellar molecules (*see "From Radio Astronomy Towards Astrochemistry," by David Buhl and Lewis E. Snyder in* Technology Review *for March, 1971, pp. 54-62*), programs to use reflected radar echos for determining orbits and mapping surface features of the moon and several planets, notably Mercury, Mars, and Venus; and a number of other astronomical studies. Users have included groups from Harvard, Smithsonian Astrophysical Observatory, National Radio Astronomy Observatory, Air Force Cambridge Research Laboratory, University of Illinois, University of Maryland, and others.

The new funding arrangement makes the Haystack Observatory available without charge to users whose projects are approved. Since the transfer, Haystack typically operates for an average of about 115 hours per week—100 hours for scientific work and 15 hours, on the average, for adjustments and maintenance, according to Paul B. Sebring, Director of the Observatory. For the present, he says, this operating schedule seems to be sufficient to meet astronomers' demands. However, the remaining 40 hours per week of operations would be readily feasible at modest additional cost. The most pressing problem at present is Haystack's need for "a comprehensive instrument upgrade"—overhaul, renewal, and some additions to the existing instrumentation, notably receivers and data processing.

The principal feature of Haystack is a 120-ft.-diameter parabolic antenna covered by a shell (radome) for weather protection. The equipment can be arranged so that Haystack operates as a radar, transmitting energy packets and then detecting and analyzing their reflection from distant targets; or as a radio telescope, simply receiving signals from the sky. In either configuration, it can be adjusted to operate with radio waves ranging from 18 to 0.86 cm. wavelength. The facility was originally designed and constructed under the direction of Herbert G. Weiss, '40, of Lincoln Laboratory, who is Engineering Director of N.E.R.O.C.

Wanted: Ombudsman

Does M.I.T. need an ombudsman—someone who can (without jeopardy, because that is his job) carry problems from the community to those who must act on them? Yes, said the Corporation Joint Advisory Committee on Institute-Wide Affairs following a preliminary discussion early this spring. C.J.A.C. members put it this way: there seem to be too many people at M.I.T. who say "go see someone else" when a complaint is lodged or a difficulty defined. Or, perhaps—as another said it—"the system is so big."

Some problems—and possible solutions—taken at random from C.J.A.C.'s discussion:

"I picture the ombudsman as having not much power but great privilege: he could go to the Academic Council and say, 'Look, I want to tell you the criticisms I've heard about this Council.' "

"I see him not working out the problem but putting people in contact with the right person."

Question: "What kind of problem would we take to the ombudsman?" Answer from another C.J.A.C. member: "I would never go. I know the way around. . . . I think most upperclassmen can get in anywhere except the Corporation. That area is closed." Another answer: "Sometimes I have a problem and do not know for sure to whom I should go." Another answer: "You can't simply take a complaint to the Provost. You must have a plan, and that is why a really good ombudsman would be a help."

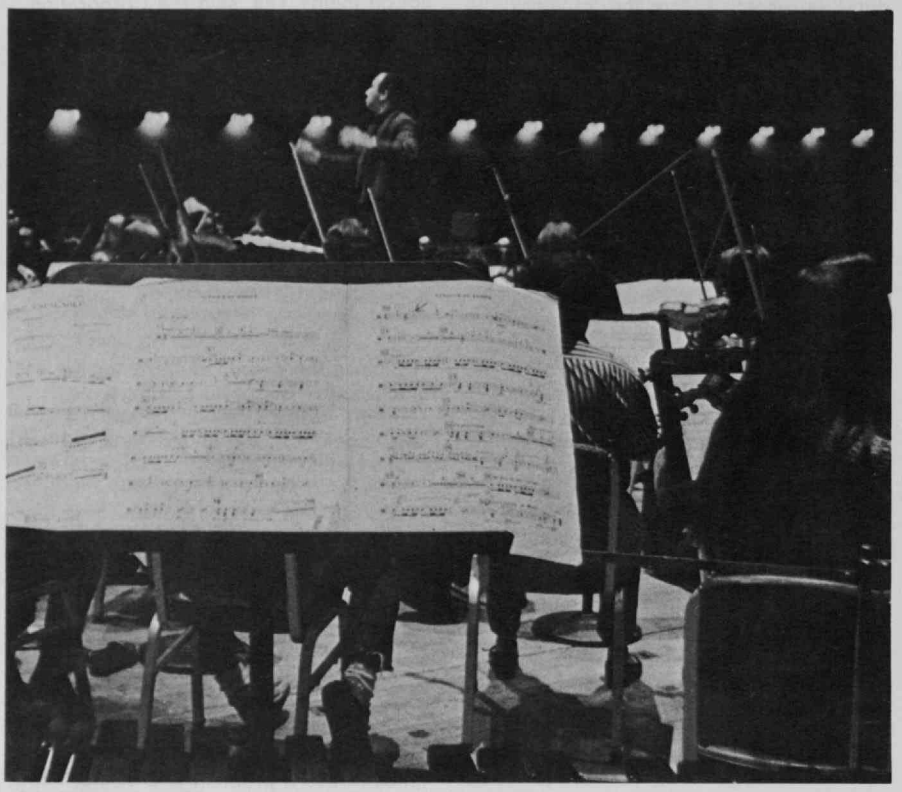
"I can see him overwhelmed with his work load. . . . I think that if he's successful he'll die of a heart attack. . . ."
"I don't think an ombudsman can take on such a problems as a secretary who says she's underpaid."

"The tendency would be to appoint a 'nice guy,' but he should be more. He should have stature. . . . I think he should be young, but I agree everyone must respect him."

Could the ombudsman be "computerized?" Yes, "to some questions he could punch a button and get the answer. . . . It would be a hell of a drum. . . . No, that's not the right approach. The data would be for old, irrelevant questions and most likely would not answer today's questions."

New York's Carnegie Hall was a sell-out to members of the M.I.T. Alumni Center of New York and their guests for April 19, when the M.I.T. Symphony Orchestra, (David Epstein, Associate Professor of Music, Conductor) played the largest of three concerts in a Spring festival of music planned to honor Dr. and Mrs. James R. Killian, Jr. ('26). The Orchestra rehearsed in the afternoon (below and opposite) and played a highly successful evening concert including Beethoven's "Emperor" concerto with John Buttrick, Assistant Professor of Music, as soloist.

Before the concert alumni gathered for a buffet arranged by Carroll J. Brown, '46 (center column, top left), where Mrs. Killian received a gift from New York alumni (with her, center, top right, are Klaus Liepmann, Director of Music at M.I.T., and John R. Wiley, '33, General Chairman of the New York alumni group); and during the concert Dr. Killian received the Center's coveted Silver Stein Award from Julius A. Stratton, '23, Chairman of the Ford Foundation. (Photos: Sheldon Lowenthal, '74, and Andrew C. Goldstein, '71)



Triumph in Carnegie Hall

The New York Alumni Center's spring festival of music—planned to honor Dr. and Mrs. James R. Killian, Jr. ('26) upon Dr. Killian's retirement as Chairman of the M.I.T. Corporation—reached its climax on April 19, when the M.I.T. Symphony Orchestra played "a concert that would have been a credit to a professional orchestra" in Carnegie Hall.

The quotation is from Theodore Strongin's review in the *New York Times.* He also said " . . . it was hard to tell the engineers, physicists, chemists or whatever, from the musicians, everyone having played so well."

The Symphony's program included works by Ravel and Maurice Perle as well as the first New York performance of "Ventures"—three pieces for a symphonic wind ensemble by David M. Epstein, Associate Professor of Music who conducts the Orchestra, and Beethoven's "Emperor" Concerto No. 5 with John Buttrick, Assistant Professor of Music, as soloist.

Carnegie Hall was sold out to M.I.T. alumni for the occasion, and at intermission ceremonies Julius A. Stratton, '23, President Emeritus of the Institute, said the event was "a magnificent outpouring of appreciation for what Dr. Killian is, what he has done for us all, and what he has achieved for M.I.T. . . . He is a man who as well as anyone in this country," said Dr. Stratton, "understands education and the promise which science holds for man." He presented the Silver Stein Award of the Alumni Center of New York to Dr. Killian.

The spring festival in honor of the Killians also included a performance of Haydn's "The Seasons" by the M.I.T. Glee Club and the Choir of Douglass College at the Lincoln Center on March 30, and a recital by the M.I.T. Chamber Music Group on May 11 in the Carnegie Recital Hall. Allen Hughes of the *New York Times* found the Glee Club—Douglass Choir performance "considerably less than ideal," but Raymond Ericson, reviewing the festival plans in the Sunday *Times* for April 4, said that M.I.T.'s strength in music was "an unexpected emphasis at a school renowned for its training of engineers and scientists."

Electric Power Laboratory

Gerald L. Wilson, '61, Associate Professor of Electrical Engineering, has been named Director of the Electric Power Systems Engineering Laboratory, succeeding Herbert H. Woodson, '52, who will leave M.I.T. at the end of the current academic year to head the Department of Electrical Engineering at the University of Texas.

The Laboratory was established in January, 1970, as a focus for interdepartmental research and teaching in electric power generation, transmission, and utilization in the M.I.T. School of Engineering; Professor Woodson was its first Director.

Professor Wilson, who has been associated with the Laboratory since its founding, has participated in creating a power engineering education program—including research activities on transformers, transmission line characteristics, circuit breakers, and electric fields. He joined the M.I.T. faculty upon receiving his Sc.D. in mechanical engineering in 1965, and a year later he served as a consultant to the electrical generation section of the American Electric Power Service Corp.

Professor Woodson, who leaves M.I.T. at the end of this month after more than 20 years studying, teaching, and research in the Department of Electrical Engineering, has been a champion of the Institute's work in electric power fields. He has been Philip Sporn Professor of Energy Processing since that chair was established in 1967.

Engineers of Distinction

Seventy-four M.I.T. alumni—more than from any other educational institution—are included in the Engineers' Joint Council list of "Engineers of Distinction" published this spring. Criteria for selecting engineers "who have assumed leadership roles in the profession" were national awards and principal assignments for national engineering societies.

The M.I.T.-Wellesley Exchange: Will Success Spoil a Panacea?

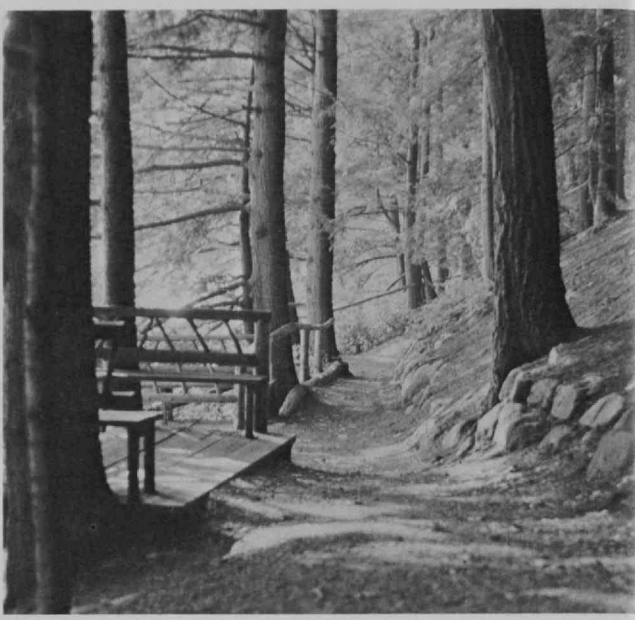
When plans for undergraduate cross-registration between M.I.T. and Wellesley were first proposed in 1967 (*see* Technology Review *for June, 1967, p. 68*), the official guesses were that between 60 and 80 students from each institution would register at the other. Four years later, the experiment is almost too successful for its own good: during the spring term just ending, some 270 M.I.T. students are taking 340 subjects at Wellesley and some 400 subjects are being studied at M.I.T. by Wellesley women.

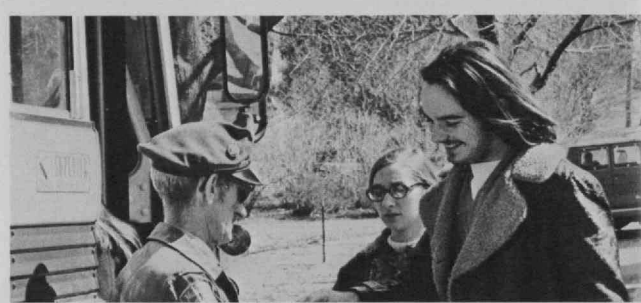
On announcing plans for the exchange in May, 1968, President Howard Johnson described its intent as "extending the opportunities open to students in each school while maintaining the integrity of each home base." The plan was expected to strengthen the position of full-time women students at M.I.T. "The success of M.I.T.'s coeds," said President Johnson, "led us to think that this new step would be appropriate."

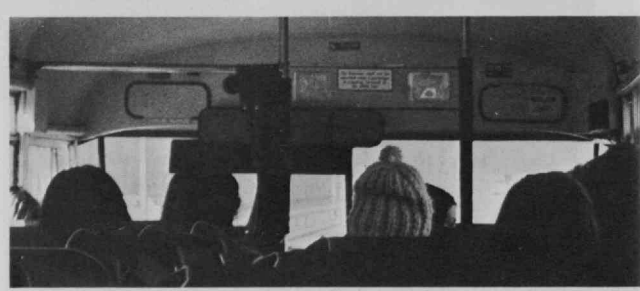
The program originally ran into difficulty when far fewer M.I.T. men expressed an interest in the program than Wellesley students. But the program's coordinators successfully sought to keep the number of courses taken at either school within 20 per cent of those taken at the other so that transfers of money for excess tuition would not be necessary.

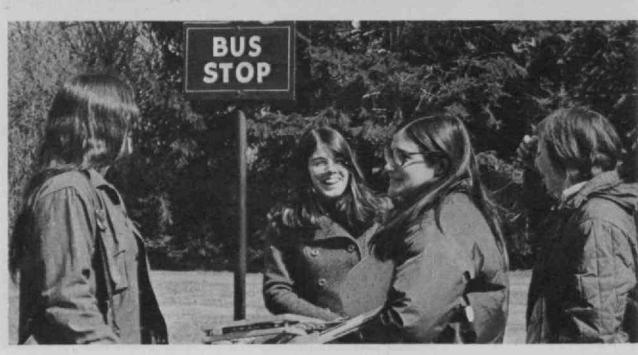
Despite—or perhaps because of—success, the future almost surely holds changes for the M.I.T.-Wellesley exchange. M.I.T. itself will admit an increasing number of coeds starting in September, 1971; at the same time, Wellesley has been expanding its exchange programs with other colleges so that men remain a small proportion of Wellesley's total enrollment. And plans for "exchange" housing—some M.I.T. men taking several Wellesley courses to live on the Wellesley campus, while some Wellesley coeds taking a number of courses at M.I.T. live at the Institute—have had a less-than-enthusiastic reception in Cambridge *(see below)*.

No one believes that the informal links between M.I.T. and Wellesley, which have been traditional for over a century, will wither. But less romantic institutions are far more subject to change. For two perspectives on the present and the future of the exchange, see the adjoining columns.









As Wellesley Sees It

Mrs. Diana Flasar, Administrative Assistant to the Dean of Wellesley College and the exchange coordinator at Wellesley, believes that the Wellesley-M.I.T. exchange has "come pretty close to its ideal format right now" and that "the exchange differs from every other exchange we know of in that the two schools are so different. It has much more appeal in a complementary academic sense than if both schools were liberal arts oriented." The exchange was conceived as an opportunity for M.I.T. and Wellesley students "to become involved in an entirely different atmosphere and educational format," Mrs. Flasar said.

"The girls say that they feel in a more dynamic situation at M.I.T. They want to get into an urban setting. The atmosphere at Wellesley has been changed greatly since large numbers of M.I.T. students became visible.

"The subject approaches are different at M.I.T., as well. M.I.T. is analytically oriented while Wellesley is more descriptive. For example, one of the most popular M.I.T. subjects among Wellesley students is 9.00, Introduction to Psychology. Emphasis is on the physiological aspects of brain science, while Wellesley offers descriptive psychology. Also, there's more discussion now in coed classes here. M.I.T. students aren't afraid to challenge a professor," said Mrs. Flasar.

The joint M.I.T.-Wellesley steering committee is now considering the institution of jointly taught courses. This does not, however, presage a closer formal union between the two. Mrs. Flasar emphasized that "each school has its own future. Being complementary is not the same as being similar."

An M.I.T. Man's View: A Spring Meadow Incarnate

by Joseph L. Kashi, '71

There are times when the vertically rising concrete and lavender-colored air of Cambridge and the Back Bay become far too jading, and escape to almost any patch of grass and lakeside forest becomes necessary to insure the continued sanity of an M.I.T. undergraduate.

Then, how much fun is it to be just another one of 4,000 men bulling at an M.I.T. residence some evening when you could be sparkling in front of a lithe, interesting Wellesley girl?

These are the fantasies of which the Wellesley-M.I.T. exchange is made.

M.I.T. and Wellesley are quite different schools; in many ways, they complement each other. M.I.T. is an aggressive, analytically oriented urban campus while Wellesley is a spring meadow incarnate, much more genteel, slower, concentrated in the liberal arts.

Many M.I.T. students register for Wellesley classes to experience a new perspective on the liberal arts or to take courses in areas only lightly covered at M.I.T. Such departments as art history, English, and political science are popular.

More likely, though, the majority of M.I.T.'s male students apply for the exchange so that "I can meet a girl in a natural classroom environment." And there's also the desire for a change of scene: A sampling of M.I.T. men who have had contact with the program indicates that the desire to flee Cambridge for the country ranks almost as high as social reasons in motivating M.I.T. students to seek a Wellesley subject.

Lake Waban and the pine-covered trails around it seem to hold for many M.I.T. students a nostalgic charm harkening back to less troubled times. Men are often there at sunset leaning, even alone, against a tree and looking out over the lake; or slowly walking along a trail with a girl held closely. Wellesley mores allow, legend says, a girl to throw her boyfriend in the lake if he walks her around it three times without proposing marriage. (If she declines, she gets the ducking.)

The M.I.T.-Wellesley exchange is ultimately more hampered by geography than by the dissimilar nature of the schools. Wellesley is about 15 miles from M.I.T. The hourly bus ride between the schools requires 40 minutes, which effectively forces students to forego classes in the hours preceding and following the time of their exchange class. Indeed, more M.I.T. students are probably dissuaded from applying to the program because of scheduling difficulties than because of any lack of interest in fields covered at Wellesley or Wellesley's repu-

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An M.I.T. Woman's View: A Basic Purpose By-passed

by Katherine Swartz, '72

Since McCormick Hall opened almost a decade ago, and there was finally a place for women students to live on campus, it has been the stated aim of the Institute to increase the number of women enrolled as undergraduates at M.I.T. In addition to strongly supporting this aim, M.I.T.'s women have also long supported the idea of exchange programs which would bring women from other universities—women oriented to the pure sciences, engineering, or the quantitative social sciences—to the M.I.T. campus for a year's study. We support such exchanges for these reasons: more women would then be educated at M.I.T.; to convince women to continue studies in quantitative fields when they might not do so without the experience of M.I.T.; and to expose the M.I.T. student community to other science-oriented students from different educational backgrounds.

However, the M.I.T.-Wellesley cross-registration program and the newly proposed residence exchange has not gained the support of M.I.T. women—largely because we feel that they lean toward social rather than educational purposes. If one looks at the record of the cross-registration program since it began three years ago, it is appalling to see how few science or engineering courses are being taken by the Wellesley women. Last term, over 30 per cent of the M.I.T. courses taken by Wellesley students were from the Department of Humanities—an area of academic strength at Wellesley. It would seem that the cross-registration program is not being used to take advantage of the special educational resources of M.I.T. Because there seems to be no great demand on the part of the Wellesley women for science and engineering courses at M.I.T., we feel that the program is unnecessary for educational purposes.

Moreover, the belief that the Wellesley-M.I.T. program is socially oriented is also partially the result of the way in which the newer proposal for a *residence* exchange came to the attention of the M.I.T. community. Except for two M.I.T. men (who had their own interests in having Wellesley women on campus) and an M.I.T. woman (who until this year was a Wellesley student), no students were consulted by the faculty committee. This particularly upset a number of M.I.T. women *and* men since rooming assignments can become a crucial problem. There is a great deal of feeling that the rooming desires of both undergraduate and graduate M.I.T. women should be met before those of Wellesley students.

Further, a number of the deans for various student affairs were also left out of the planning of the proposal. Had they and more M.I.T. students been consulted,

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Man's View (continued)

tation for stiff grading. (Wellesley courses are C-centered; the average grade in an M.I.T. course is a B.)

The free bus transportation between Cambridge and Wellesley has proved to be one of the most popular aspects of the exchange. Overcrowding became a problem when many students not taking courses tried to use the free buses to get into the city or away from it. Because cross-registered students were often unable to find a seat and get to class on time, the committee was forced to return to a ticket system. All exchange students now have tickets which assure them of first seating preference.

Nevertheless, the free bus continues to promote a greater amount of interchange between men and women of M.I.T. and Wellesley. M.I.T. men are more frequently going to Wellesley for an evening at the library or to eat with a friend in a dorm. It's not very difficult to date a Wellesley girl when the M.B.T.A. is no longer the sole means of transportation for the car-less. There has also been a noticeable rise in participation by Wellesley students in Boston-Cambridge service organizations since the bus shuttle began.

Woman's View (continued)

many of the problems with procedural details might well have been avoided. What might also have been avoided is the distinct impression, which many M.I.T. people (not just the women) have, that the residence exchange was proposed for the social benefit of the M.I.T. men and the Wellesley women.

The result of all this is that M.I.T. women now are coming to view the M.I.T.-Wellesley exchange as running at cross purposes to the idea of educating more women in the quantitative fields at M.I.T. Having women from Wellesley on campus in a social rather than primarily educational exchange is not very beneficial to the future of M.I.T. as their presence may exclude other women seriously aspiring to the study of science and engineering.

What might prove beneficial, instead, is a program to recruit women from across the country to spend their sophomore, junior, or senior year at M.I.T. These would be women who were genuinely interested in interacting with M.I.T. women and in science, engineering, or the quantitative social sciences, so that they would take advantage of M.I.T.'s special educational resources and approach to scholarship. More women might then think of coming to M.I.T. for graduate school here, and this would significantly increase the number of truly excellent women involved in industry and university research and teaching—a bonus for society.

In any event, M.I.T. should not forget that its first obligation lies in educating individuals aspiring to perform with excellence in science, engineering, and the quantitative social sciences—and that women are in this group as well as men.

E. Moreau Brown, Associate Secretary of the General Electric Foundation (left), poses with James R. Killian, Jr., '26, chairman of the M.I.T. Corporation, on the occasion of payment by General Electric of the first installment on a $500,000 grant to support construction and equipping of a new building for M.I.T.'s Department of Electrical Engineering.

General Electric Gift

A $500,000 grant to M.I.T. from the General Electric Co. and General Electric Foundation will support construction of and equipment for a major new building now being planned for the M.I.T. Department of Electrical Engineering (*see* Technology Review *for July/August, 1970, p. 94*). Of the total, half will be fulfilled by gifts of equipment to be used in the building, either for instruction or as building utilities; and $250,000 is in the form of a cash grant.

Faculty Promotions

Promotion of 19 members of the M.I.T. faculty to the rank of Professor and of 33 to the rank of Associate Professor have been announced by Jerome B. Wiesner, Provost of the Institute. The new ranks are effective July 1.

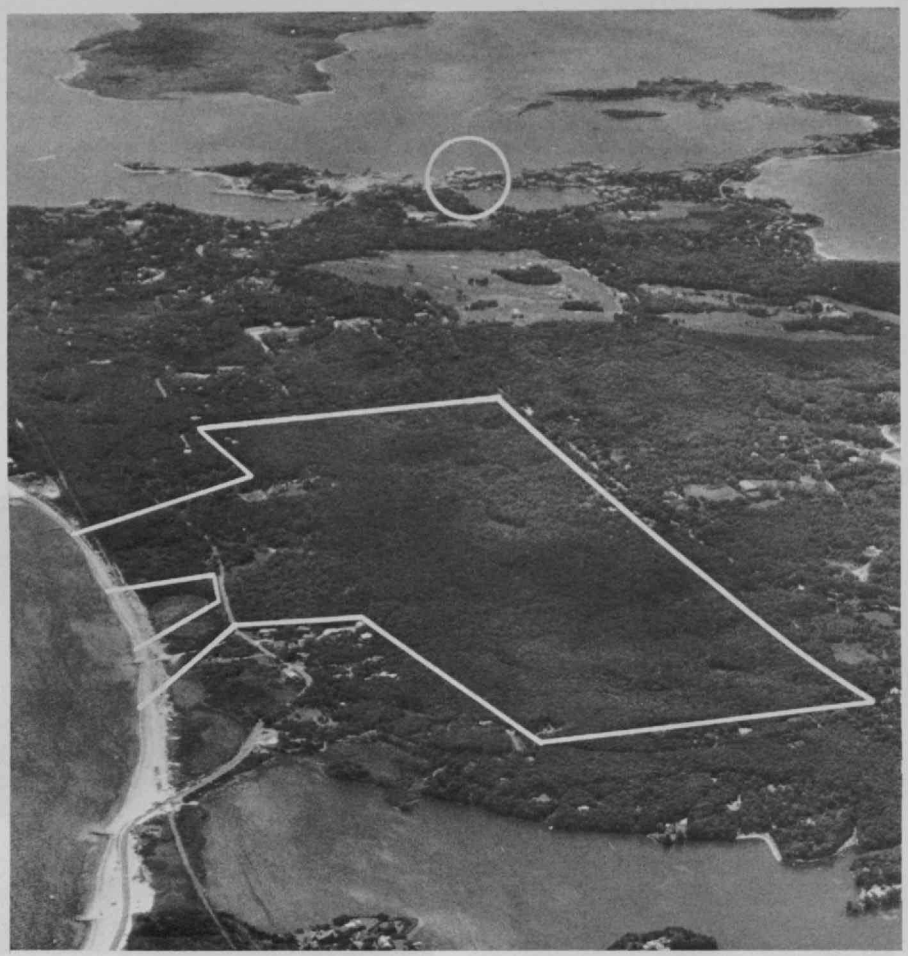
The following were promoted to Professor:

Arden L. Bement, Nuclear Engineering
Abraham Bers, '56, Electrical Engineering
Jerome J. Connor, Jr., '53, Civil Engineering
David M. Epstein, Humanities
Kenneth L. Hale, Foreign Literatures and Linguistics
Robert E. Jones, Foreign Literatures and Linguistics
Alvin G. Kibel, Humanities
Robert S. Lees, Nutrition and Food Science
Koichi Masubuchi, Naval Architecture and Marine Engineering
John R. Myer, '52, Architecture
Lisa R. Peattie, Urban Studies and Planning
Sheldon Penman, Biology
Daniel G. Quillen, Mathematics
Peter H. Schiller, Psychology
Robert W. Simpson, Ph.D.'64, Aeronautics and Astronautics
Kenneth A. Smith, '58, Chemical Engineering
Maurice K. Smith, '54, Architecture
M. Nafi Toksoz, Earth and Planetary Science
David G. Wilson, Mechanical Engineering

The following were promoted to Associate Professor:

Suzanne Berger, Political Science
Louis L. Bucciarelli, Ph.D.'66, Aeronautics and Astronautics
Stephen K. Burns, '62, Electrical Engineering
John W. Devanney, III, '62, Naval Architecture and Marine Engineering
John J. Deyst, Jr., '58, Aeronautics and Astronautics

For 40 years the Woods Hole Oceanographic institution has been crowded into buildings (circle) fronting the dockside area of Woods Hole, Mass., a congested summer resort village fronting on the equally congested waterway connecting Nantucket Sound, Vineyard Sound, and Buzzards Bay. Now it has acquired and is starting to develop a new campus on Vineyard Sound east of the village.



Robert S. Freeman, Humanities
Devendra P. Garg, Mechanical Engineering
Julius L. Goldstein, Electrical Engineering
Robert Goodman, '60, Architecture
Philip B. Herr, M.C.P.'59, Urban Studies and Planning
Langley C. Keyes, Jr., Ph.D.'67, Urban Studies and Planning
Rosalind E. Krauss, Architecture
James D. Litster, Ph.D.'65, Physics
Harvey F. Lodish, Biology
Thomas B. McCord, Earth and Planetary Sciences
Michael Modell, '60, Chemical Engineering
Joel Moses, Ph.D.'67, Electrical Engineering
James P. Moran, '59, Aeronautics and Astronautics
Francis C. O'Brien, Jr., Athletics
Ronald R. Parker, S.M.'63, Electrical Engineering
Gerald A. Pogue, Management
William K. Rose, Physics
Irwin M. Rubin, Ph.D.'66, Management
Paul R. Schimmel, Ph.D.'67, Biology
Anthony J. Sinskey, Sc.D.'67, Nutrition and Food Science
H. Eugene Stanley, Physics
John A. Steffian, Architecture
Joseph M. Sussman, Ph.D.'68, Civil Engineering
Neil F. Todreas, Sc.D.'66, Nuclear Engineering
Pin Tong, Aeronautics and Astronautics
Preetinder S. Virk, Sc.D.'67, Chemical Engineering
James N. Walpole, Ph.D.'66, Electrical Engineering
Daniel E. Whitney, '60, Mechanical Engineering

Woods Hole's New Campus

Woods Hole Oceanographic Institution has announced plans for a new 184-acre Quissett Campus which will lie on rolling wooded hillocks overlooking Vineyard Sound. The Institution broke ground in early March for the $8 million first stage of building its proposed $12 million campus. By 1973 it hopes to have completed the first three buildings, one of which will be the GEOSECS Center for the International Decade of Ocean Exploration's Geochemical Ocean Section Study. The other two will be the Data and Earth Sample Center (D.E.S.C.) and a chemotaxis studies laboratory.

For the second stage (1973–1975) in the campus' initial development, the Institution plans a $2 million conference center, as well as a library and apartments for staff and students costing another $2 million. It is also considering an Environmental Systems Laboratory where staff and students would study pollution control, aquaculture ("sea-food farming"), and general environmental problems.

W.H.O.I. is becoming increasingly involved in national and international marine affairs. It is also, by Commonwealth charter amended in 1967, a graduate degree-granting institution; the number of students enrolled in the M.I.T./W.H.O.I. joint degree program has risen from 20 in 1968 to over 50 in 1971. Beginning this fall, the Institution will sponsor three postdoctoral fellowships in marine policy and ocean management. Those who receive these fellowships will study problems of public policies for the oceans, ranging from arms control in the sea to ecological problems of ocean resources exploitation.

These are the reasons, explains Paul M. Fye, W.H.O.I. President and Director, for beginning now to build the Quissett Campus. He has said that finding space ashore, especially for scientists, is most critical. W.H.O.I. scientists hope that the increased space at Quissett will provide more room for their research projects and more room for the graduate students who come to Woods Hole for what Dr. Fye and several of his colleagues have called "the best kind of graduate training: participation in research."

As the Institution's educational and research programs expand, its funding must increase. The $12 million it needs to complete the initial development of the Quissett Campus is part of a $38 million development campaign it began in 1967; it has already received $18.6 million of this in gifts or pledges.

Among the reasons W.H.O.I. is seeking funds is to endow students and faculty in the new education program, to support a student-oriented research vessel, and to insure that the Institution will have adequate laboratories and classrooms for its growing student enrollment.

The nine-day GEOSECS seminar which W.H.O.I. will hold in September is an example of the Institution's expanding programs. The Institution will have $627,500 (from the $3 million the National Science Foundation granted this year to seven oceanographic institutions for GEOSECS, the first major research project of the International Decade of Ocean Exploration) for its study of samples from the Atlantic, Pacific, Indian, and Antarctic Oceans. W.H.O.I.'s GEOSECS cruises in the Atlantic will run from July, 1972, to March, 1973. During these cruises scientists will collect samples—which will be stored in the GEOSECS Center at W.H.O.I.—and study them to learn more about the seas' pollutants, their mixing processes, and their production of organic matter.

In February the Institution also received over $1.9 million in seven National Science Foundation grants for research this year. The largest of these—over $1 million—will provide part of the funds W.H.O.I. will use to operate its research vessels. The other N.S.F. grants are for continuing research in geology and geophysics, biology, chemistry, and physical oceanography. W.H.O.I.'s current operating funds come mostly from N.S.F.,

When some 100 M.I.T. alumni gathered in Cambridge this spring to discuss engineers' career problems, John D. Alden, '49 (center, top picture), of Engineers' Joint Council told them the real problem is not national priorities but the nature of their business: technology is changing so fast that engineers become obsolete on a time scale much shorter than one man's career; there are few resources for continuing education to protect such victims; there is no national manpower planning; and the profession cannot make itself heard because it makes too much "random noise," he said. Secor D. Browne (left, below), Chairman of the Civil Aeronautics Board, had some simple advice: "If you are to be 'converted,' you are the one who must do it." And Jerome B. Wiesner (right, below), Provost of M.I.T., opened the session with a revealing commentary on how the Kennedy administration anticipated today's problems—but found itself powerless to intervene (see p. 72).

the Office of Naval Research, the Atomic Energy Commission, and the U.S. Geological Survey.—*Lucy Sloane*

Toward a Diverse Society: Everything's Not Up to Date

After listening to two days of panels and discussions about current economic conditions, the changing demands for scientists and engineers, and the future prospects for professionals in the U.S., John B. Mathis, Ph.D.'69, Assistant Professor of Chemistry at Bowdoin College, summarized the Alumni Association's Career Seminar of April 17 and 18 this way: the wave of the future is moving "toward the man who can see himself in several disciplines, as having skills interfacing on several areas."

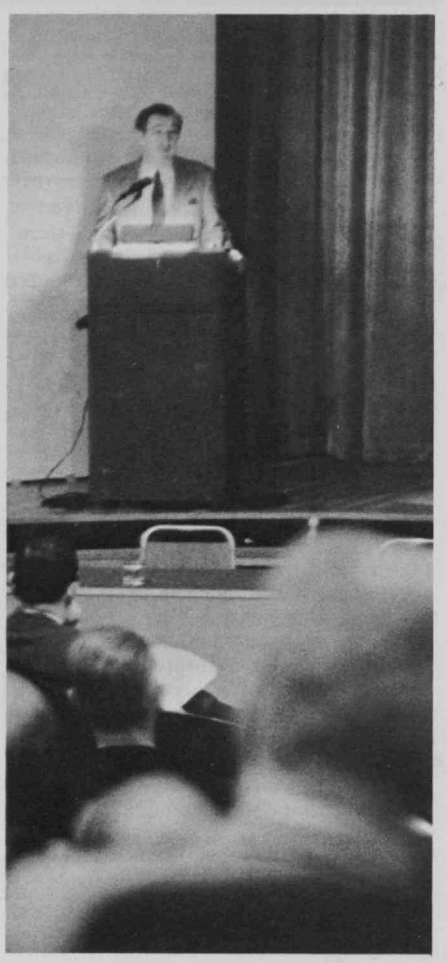
The advice for an alumnus now looking for a job or a change in career is: "Look carefully at yourself," Dr. Mathis said. See what your strengths really are, and look especially for how they might interface with problems and demands.

Secor D. Browne, Chairman of the Civil Aeronautics Board, said the same thing in his seminar keynote address Saturday evening: his future depends on the individual. "You must realize," he said, "that education at M.I.T. was only a beginning. You can do what you decide to do; you are the individual who must look after yourself; if you are to be 'converted' you must do it. And you probably can."

No one could have left the seminar with any sense that the world of science and engineering will be the same in the decade of the 1970's as it was in the 1960's: emphases will be different, funding will be different, even education must be different.

Perhaps the most pessimistic view came from Paul A. Samuelson, Professor of Economics, who paraphrased the maxim which used to be recited to M.I.T.'s freshmen each fall: "Look to your right, and look to your left. One of you won't be an engineer next year" (*see Trend of Affairs, pp. 00-00*).

Irwin W. Sizer, Dean of the Graduate School, turned out to be an optimist. He



refused to paraphrase the song from *Oklahoma*: "Everything's up to date in Kansas City; we've gone about as far as we can go!" But everything's not "up to date" in cell genetics, said Dean Sizer; indeed, he insisted, no area of science or engineering has "gone as far as it can go"; plenty of work remains.

The seminar was only a manifestation of a far bigger problem, said Jerome B. Wiesner, M.I.T. Provost; the nation—just as are individual M.I.T. graduates—is "wrestling with questions of the evolution of science and technology," and we all lack sensitive processes for weighing alternatives. As for M.I.T., said Dr. Wiesner—who becomes the Institute's 13th President on July 1—we must "address ourselves to making achieving processes of evaluation which allow us—even under present conditions—to be a diverse and experimental society."

"Burglarous Instrument"

Stephen D. Krasner, '70, indicted by a Grand Jury in March, 1970, for the manufacture of a "burglarous instrument"—the battering ram used to break down the door of President Howard W. Johnson's office by students intent on occupying it in January, 1970—is now serving a one-year sentence.

Prosecution of the case was not undertaken by M.I.T., though four members of the faculty and staff testified during the short jury trial early this spring. The District Attorney's case against Mr. Krasner had been first dismissed in a lower court and then reinstated by the Massachusetts Supreme Court; arguments in Middlesex Superior Court hinged on the question of whether the instrument, clearly manufactured by Mr. Krasner, was intended by him for the use to which it was eventually put.

Under Massachusetts law, the sentence is heavier for the "burglarous instrument" charge than for the "trespass" charge to which it led for the other young people who were identified in connection with the occupation. Reporting in *Thursday*, Bruce S. Schwartz, '73, called the courtroom scene "pathetic, a minor tragedy: no angry crowds, no noisy demonstrations—these are not part of this current cycle—only the finality of doors that swing shut and lock," he wrote.

The Nuremberg Chronicle

An early-printing copy of *The Nuremberg Chronicle*, one of the finest books printed during the earliest period of typography, has been given to the M.I.T. Libraries by Samuel ('25) and Dorothy Glaser. It represents the most valuable single volume now in the Libraries' growing collection of rare books, according to William N. Locke, Director of Libraries.

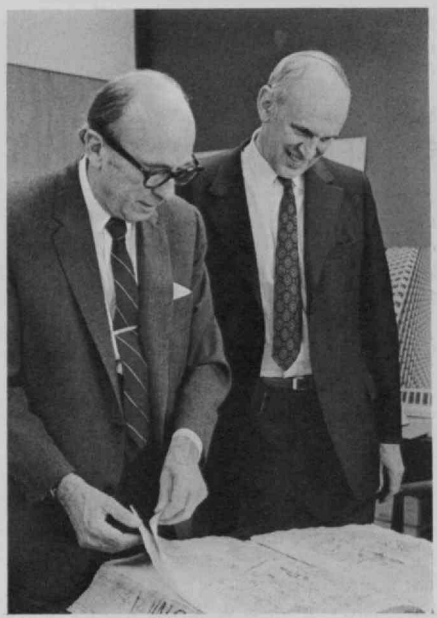
The Nuremberg Chronicle is a history of the world written by Hartmann Schedel and published in Nuremberg by Anton Koberger in 1493. It is notable especially for its illustrations, consisting of 645 separate blocks which occur 1,809 times through the text; the book has been called "a landmark in the history of illustration (which) cannot fail to impress by sheer size and by the quality of its cuts."

Mr. Glaser acquired his copy within the last five years during a visit to Switzerland; he hopes its presence in the Libraries' Rare Book Room will lead many members of the Institute community to discover the interest and joy which Mr. Glaser himself has found in rare-book collecting.

An Astronaut without Ceremony

The time has come when an astronaut recently back from the moon can return to his alma mater for a speaking engagement with no more fanfare than a terse mention in the Institute Calendar. Captain Edgar Mitchell, Sc.D.'64, late of Apollo 14, gave an Aeronautics and Astronautics Department seminar in the same pit-shaped lecture theater that the Department always uses for its seminars. In spite of the lack of publicity, room 35-225 was for once completely filled—establishing that the routine channels of communication really work.

Captain Mitchell began by explaining his beard. A crew which includes Alan Shepard is liable to become known as "Shepard and those other two guys." He grew a beard so that the team would be-



When William N. Locke, Director of M.I.T. Libraries (right), returned The Nuremberg Chronicle *to its donor to pose for this picture, Samuel Glaser, '25, of the Boston architectural firm of Samuel Glaser and Partners, remarked on "how dangerous it is to let me see this again." Having given it to the M.I.T. Libraries, Mr. Glaser said, he was tempted by nostalgia to reclaim it for his own collection.*


Prima etas mundi

Five names associated with M.I.T. now appear on maps of the lunar surface, following the meeting last fall of the International Astronomical Union acting on recommendations of its Working Group on Lunar Nomenclature. Four scientists from M.I.T. made the grade: Karl T. Compton, Harlan T. Stetson, Robert J. Van de Graaff, and Norbert Wiener.

come "Shepard, the guy with the beard, and that other guy." Unlike many bearded citizens today, he was not trying to "find himself," he was trying to ensure that *other people* would find him.

He spoke of the long walk to Cone Crater, and the difficulty of finding one's way among the 15-foot-high "dunes" of Fra Mauro, with the horizon often only 150 feet away: "We weren't lost, we just didn't know it." The technique of walking on the moon was very like trampoline jumping, only on a 4-inch-deep layer of talcum powder.

Apollo 14, he said, "turned the corner" from the development phase of a transportation system to the bringing back of real science. It was a data point, and the remaining three Apollos would be bigger and better data points. Beyond that, it seems that there will be a hiatus in manned space flight, for the shuttle cannot be expected to fly until the end of the 1970's. Captain Mitchell was hopeful, though, that the mood of the public would support some additional interim flights with the spare spacecraft left over from the cutback Apollo program. Of Russia's space station he said: "We wish them well. We need the competition."

What lies beyond the shuttle? To use it properly, we must develop a station of some sort. We can do whatever we want to do, said Captain Mitchell: there is no limit. But space exploration will remain research. As far as the public is concerned, it is no longer enough to climb mountains merely because they are there. In the past, the explorers of space have always touted the long-term value of new knowledge. Either new justifications must be found, or people must be educated to the point where they share the space program's traditional goals: preferably both.

Speaking of technology in general, Captain Mitchell said that he believed that it had been used improperly—not out of conscious malice, but nevertheless there had been a failure to clean up our messes as we went along. (You have perhaps known what it is like, he said, to share a laboratory with a partner who leaves you to clean the glassware.) Technology can be used to clear up the mess of past activities.

He did not believe that everything should be government directed but nevertheless we should all remember, he said, that we have a greater duty than to produce some interesting new gadget. We must see that what we make is "benign," or that it can be made benign.

After the last of the Apollos, how long before another American sets foot on the moon? Twenty or 25 years, he said, and it will not be done unless a good reason is found. There might be an analogy with the study of the Antarctic: for a long time, explorers made only occasional visits. Then the Australians realized that their weather was bound up with Antarctic meteorology, and at that point continuous observation began.

Someone asked Captain Mitchell about the telepathy experiment that he performed during the journey to the moon (attempting to "send" to a medium on Earth). Emphasizing that it had not been a N.A.S.A. project, he replied that final results were not yet available. The data were still being evaluated in two different laboratories, but it appeared that they were better than would be expected to happen by pure chance.

Names on the Moon

More than 500 craters, principal features on the moon's far side which has been seen by man only in this decade, now bear the names of famous scientists—and of others associated with rocketry and space flight. Among them: four men important in the history of M.I.T.

◇ Compton (for Arthur H. and Karl T. Compton, the latter President of M.I.T. from 1930 to 1949), a large crater at 55° N., 105° E.

◇ Stetson (for Harlan T., who was affiliated with the M.I.T. Department of Geology through work in magnetism from 1936 to 1949), a crater at 40° S., 119° W.

◇ Van de Graaff (for Robert J., Professor of Physics from 1931 to 1960), twin

craters near the Sea of Ingenuity at 27° S., 172° E.

◇ Wiener (for Norbert, a member of the Mathematics Department from 1919 until his death in 1964), a large crater north of Mare Moscoviense, at 41° N., 146° E.

The name of Edwin Aldrin, Sc.D.'63, the pilot of the lunar module of Apollo 11 who was the second man to set foot on the moon, has now been given to a near-side crater, one of three near the Sea of Tranquility named for the Apollo 11 crewmen.

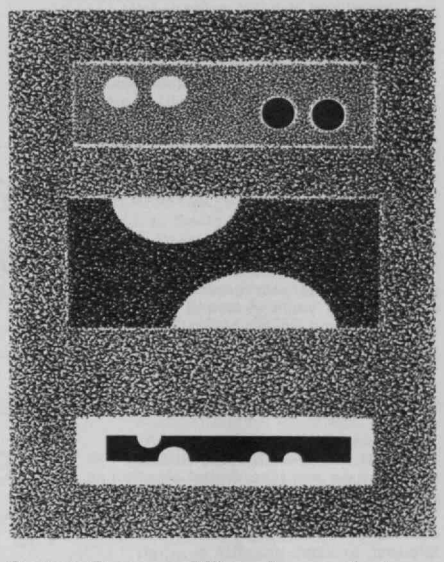
Individuals Noteworthy

To **Julius A. Stratton,** S.M.'23, M.I.T. President Emeritus, the Offshore Technology Conference Distinguished Achievement Award for Individuals . . . to **Carl I. Wunsch,** '62, the James B. MacElwane Award, American Geophysical Union, National Academy of Sciences . . . to **S. Donald Stookey,** Ph.D.'40, the American Chemical Society's Award for Creative Invention . . . to **Elwyn Ralph Berlekamp,** Ph.D.'62, Honorable Mention in the Eta Kappa Nu Recognition of Outstanding Young Electrical Engineers . . . to **Elias J. Corey,** Ph.D.'48, the American Chemical Society's Award for Creative Work in Synthetic Organic Chemistry . . . to **Serope Kalpakjian,** S.M.'53, the Award for Excellence in Teaching from Illinois Institute of Technology . . . to **F. R. Morral,** '32, the Technical Man of the Year Award, Columbus Technical Council . . . to **Frank Staples,** '27, the Sugar Man of the Year Award for 1970, B. W. Dyer and Co. . . . to **Lauren Hitchcock** '20 a Professional Achievement Award, American Institute of Chemical Engineers.

To **Charles E. Huckaba,** S.M.'47, the Distinguished Engineering Alumnus Award, University of Cincinnati . . . **Benjamin P. Blasingame,** Sc.D.'50; **Rolf Eliassen,** Sc. D.'32; **Lester Lees** S.M.'40; **John G. Linvill** Sc.D.'43; **Robert G. Loewy,** S.M.'48, to National Academy of Engineering . . . to **Bernard F. Burke,** '50; **Patricia P. Crowther,** '64; **James M. Moran, Jr.** Ph.D.'68; **Alan E. E. Rogers,** Ph.D.'64; **Kenneth I. Kellerman** '59, the Rumford Award, American Academy of Arts and Sciences. . . . **Louis Stark** S.M.'50, to fellow of the Institute of Electrical and Electronics Engineers . . . to **John E. Sheats,** Ph.D.'66, the Frederick Gardner Cottrell grant from the Research Corp. of New York City . . . to **Martin L. Breidenbach,** Ph.D.'65, and **Stephen G. Simpson** Ph.D.'61, post doctoral fellowships from the National Science Foundation . . . **Charlie Batterman** M.I.T. Swimming Coach, named Distinguished Coach, College Swimming Coaches Association of America . . . to **Frank Press,** Shrock Professor of Geology and Geophysics, the gold medal award from Britain's Royal Astronomical Society.

Herbert R. Moody '41, to President and General Manager, Micromedic Systems, Inc. . . . **A. Sidney Brookes,** '26, to Underground Systems Engineer, Public Service Electric and Gas, Co., New Jersey . . . **Hatten S. Yoder, Jr.** Ph.D.'48, to Director of Geophysical Laboratory, Carnegie Institution . . . **Richard W. Douglass** '57, to Vice President and General Manager, Improved Laminated Metals Co. . . . **William F. Beck,** Sc.D.'64, to Marketing Manager—C.D.B., F.M.C. Corp. . . . **M. Gertrude Howell,** Ph.D.'59, to Director of Technical Information Services, Lederle Laboratories, Division of American Cyanamide Co. . . . **Francis C. Hyson,** '52, to Research Director and Member of Investment Committee, Newmark, Posner and Mitchell, Inc. . . . **J. Karl Justin,** '48, to Vice President and Director of Project Administration, Max. O. Urbahn Associates, Inc. . . . **Charles Pimlott,** S.M.'58, to Marketing Manager—bakery products, Stouffer Foods Division of Litton Industries . . . **Mario P. de Figueriredo,** Ph.D.'55, to Vice President, Research and Development, Hollywood Brands, Consolidated Foods Corp. . . . **R. N. Creek,** '47, to Vice President, Administration, Union 76 Division, Union Oil Co. of California. . . . **William G. Evans,** S.M.'69, to Director, Chicago Penumatic Tool Co. . . . **John J. Magarian,** '52, to President, Bowmar Canada Ltd., Ottawa, Ontario . . . **Carthrae M. Laffoon** '42, to Senior Vice President, San Diego Gas and Electric Co. . . . **Chester W. Diercks,** S.M.'62, to Director of Corporate Planning, Allis-Chalmers, Milwaukee . . . **Richard J. Steele,** '46, to Certified Management Consultant, Institute of Management Consultants, Inc. . . . **James A. Abrahamson,** '55, to Director Maverick (A.G.M.-65)

An example of the work of Richard Filipowski, Associate Professor of Architecture, M.I.T., shown at the Joan Peterson Gallery in Boston this spring.



System Program Office, Aeronautical Systems Division, Wright-Patterson A.F.B. . . . **David W. Dennen** '54, to Director of Antibiotic Development, Eli Lilly and Co. . . . **George A. Snyder,** S.M.'59, to Manager, Technical Analysis Section, Dravo Corp. . . . **Earl E. Patterson,** Sc.D.'50, to General Director, Metallurgical Research Division, Reynolds Metals Co. . . . **Richard E. Quinn,** '56, to Manager, Technical Services, R.C.A. Laboratories, Princeton, N.J. . . . **Kendrick B. Melrose,** S.M.'65, to Director of Market Planning, Vernon Pope Co., Inc. . . . **Willis B. Reals,** S.M.'47, to General Manager—International Division, Supply and Distribution Department, Texaco, Inc. . . . **Pyam W. Williams,** '36, to Board of Directors, Robertson Paper Box Co., Inc. . . . **Alan M. Voorhees,** M.C.P.'49, to First Vice Chairman, Alan M. Voorhees and Associates, Inc. . . . **C. B. Woodhall,** S.M.'61, to Manager, Fuel Sales, Muller Jordan Herrick Inc. . . . **William T. Wise,** S.M.'48 to Vice President, International for Riker Laboratories, Inc. . . . **Marshall E. Alper** Sc.D.'51, to Manager, Jet Propulsion Laboratory's Civil Systems Project Office, Pasadena . . . **Richard A. Allen,** '49, to Manager, New Product Development Department, Industrial Nucleonics Corp. . . . **Paul Grady,** '51, to Marketing Specialist, Thiokol Chemical Corp. . . . **Robert J. Corless,** '47, to President of American Olean Tile Co. . . . **Norman L. Laschever,** '40, to Chief En-

Talent Available

These announcements are published in *Technology Review* without cost for graduates of the Massachusetts Institute of Technology who have registered their interest in new professional opportunities with the Institute's Alumni Placement Office. Such alumni are invited to submit statements, not exceeding 50 words and including relevant details of field and date of degree, professional experience, and interests to the Editor, *Technology Review,* Room E19-430, M.I.T., Cambridge, Mass., 02139. Each announcement will be published in a single issue of the *Review;* subject to the availability of space, announcements received by the 25th of each month will appear in the *Review* published five weeks later. The identity of advertisers will not be revealed either in print or in correspondence; respondents' letters, addressed to the appropriate key number at *Technology Review,* will be forwarded unopened to the advertiser.

Marketing Manager: S.B. 1953, S.M. 1957 in management engineering; 10 years experience marketing electronic consumer goods and instrumentation—responsible for up to $20 million annual sales; four years experience production and general management—same fields. Salary: over $30,000. Key JUA 1

Operations Management or Consulting: B.S. civil engineering, S.M. industrial management 1967, four years experience civil engineering and construction, four years project planning, production and inventory control; languages: French, Spanish Swahili; just returned from travel and climbing trip in South America; seeking responsible, challenging, varied job with good prospects. Key JUA 2.

Two-culture Bridge: An astrophysicist with a foot on each side seeks a new field. S.B. physics and one year graduate study in astronomy; four years industrial research in astrogeophysics and related topics including nuclear effects. Heavy interest in writing, other interests in teaching, photography, and travel. Young, resilient, and quick-learner. Available July for full- or part-time work, Greater Boston. Key JUA 3.

Electrical Engineer: B.S.'67, S.M.'69. Has worked two years on real-time digital simulations. Age 25. Not committed to a specific vocation. Interested in teaching, designing, research, machine and human languages. New England, Midwest, or West. Key JUA 4.

Production Manager: S.B.'48 in business administration, graduate work in industrial engineering. Seven years industrial engineering and 15 years as Production Superintendent in steel manufacturing, receiving tubes, microwave diodes, voltage reuglators and diode rings for car alternators. Desires position with steady, progressive company. Key JUA 5.

Construction Management: A.B.-S.B.'49, registered professional engineer; 22 years association with leading owners, architects, engineers and contractors in administration of all phases of facilities development programs: optimum utilization of capital, time, staff, consultants; negotiations with architects and contractors; coordination of programming, planning, cost studies, and design; development on contractual terms and conditions; bidding procedures, contract negotiations; construction operations, cost-progress control, project close-out procedures. Currently independent consultant, seeking challenging assignment. Key JUA6.

Operations Research of Urban Systems: Seven years experience in operations analysis, simulation modelling and development of large-scale information systems, utilizing a time-shared data base; S.B. in aeronautics and astronautics,'64; M.A. in political science,'71; recently involved in study of scale and efficiency of police agencies; desire position involving the application of work experience and education to urban problems; age 29; will relocate. Key JUA 7.

Engineering-Economics: S.B.'62 mathematics; M.S.,'70, engineering-economic systems. Experience: automobile-crash investigation and analysis, cost-effectiveness analysis of defense systems, computer programming (battle simulation, ionospheric studies). Interests: health, transportation systems, population growth, land use. Location unconstrained except New York City. Salary open for challenging, socially-productive work. Key JUA 8.

In Japan: S.M. management. Several years experience in international business, now located in Tokyo. Bilingual. Desires assignments from small businesses to locate Japanese suppliers or distributors, do feasibility studies for possible licensing or joint ventures, etc., arrange contacts for business trips of stateside executives. Key JUA 9.

Materials Scientists/Metallurgist: Sc.D.'68, age 29. Three years experience with administration, research, and teaching in magnetic tape development, powder metallurgy, corrosion, hydrogen embrittlement, dispersion strengthening, and titanium. Expertise in vacuum testing, swaging, creep, and scanning and transmission electron microscopy. Salary and location open. Key JUA 10.

Computer Science: S.B.'52 in electrical engineering, Ph.D. in computer science and communications theory. Sales development, value analysis and economics in engineering; mathematical modeling of environment and vehicles; domestic and overseas field experience. Desire position in engineering or technical sales in the computer or industrial instrumentation field. Worldwide relocation acceptable. Age 40. Key JUA 11.

Physics Mathematics: S.B. in physics, S.M. in mathematics, both '61, with considerable more graduate work in both fields. Seek position dealing with air pollution or aviation systems. Recent employment (three years) in atmospheric physics and chemistry, particularly applied to nuclear effects and discrimination. Key JUA 12.

Engineering Management: Seeking position with employer who considers capabilities more important than experience. Broad background includes customer contacts and direction of specialists in many fields. Good communicator and analyzer. S.B. and M.S. in aeronautical engineering plus courses in electronics and data management. Will learn essentials of new industry. Key JUA 13.

Product Assurance—Engineering Management: S.B. and S.M. in electrical engineering (communications); registered professional engineer. Twenty years development/production experience for three "Fortune-500" companies, covering: electronic components, actuators, flight control instruments, guidance/nav systems including electroptic, radiometric and far-IR. Eleven U.S. patents. Special skills: proposals; planning and conducting reliability and quality engineering programs; instrumentation for complex environmental tests; value engineering for cost avoidance studies. Key JUA 14.

Chemistry and Humanities: S.B.'70 in humanities and chemistry; one year experience teaching high school science and mathematics. Interested in ecology, laboratory work, teaching, archeology, writing, and music. Key JUA 15.

International Management: Young executive with background in international business seeks position requiring travel or assignment in Southeast Asia or the South Pacific. S.B.'68, S.M.'69, both in management; work experience in Honolulu, Boston, Paris, and Tokyo. Key JUA 16.

Chemical Engineer: S.B.'65, S.M.'66 including School of Chemical Engineering Practice. Five years' experience in process engineering, process development, project engineering, and pollution control. Have worked with both organic and inorganic processes. Desire a position in process development involving the technical and economic evaluation and development of chemical processes. Key JUA 17.

gineer, R.C.A. Aerospace Systems Division . . . **Robert S. Kelso** '43, to President, Cornell Aeronautical Laboratory, Inc. . . . **Jerry R. Collen,** '57, to Vice President and General Manager, Visual Security Systems, Inc. . . . **Robert L. Mitchell,** S.M.'47, to President, Celanese Chemical Co. . . . **George B. Benedek,** M.I.T. Professor of Physics, Member of Governing Board for 1971 American Institute of Physics . . . **Albert L. Kaye,** Sc.D.'31, to Full Professor, Metallurgical Engineering Technology, Purdue University . . . **John N. Hobstetter,** '39, to Associate Provost for Academic Planning, University of Pennsylvania.

M.I.T. appointments: **Robert W. Morse,** former President of Case-Western Reserve University, to Director of Research, Woods Hole Oceanographic Institution . . . **Gerald L. Wilson,** Sc.D.'61, to Director of Electric Power Systems Engineering Laboratory, M.I.T. . . . **Robert S. Pindyck,** S.M.'66, to Assistant Professor in Sloan School of Management.

Deceased

Benjamin F. Clark, Jr., '01, July 15, 1968
Frederic A. Olmstead, '03, September 21, 1970*
Willis H. Mason, '08, September 1, 1968
Newman B. Gregory, '09, July 9, 1968
William Newsome Eichorn, '13, April 14, 1971*
Eastman A. Weaver, '15, April 7, 1971
Edmund R. Stearns, '15, March 31, 1971
Freeman Clarkson, '16, February 27, 1971
William Dodge, '16, February 21, 1971*
Albert M. Lovenberg, '16, April 2, 1971*
Dexter North, '16, April 11, 1971*
Cornelius V. Knox, '18, November 8, 1970
Medwin Matthews, '20, April 8, 1971
Benjamin E. Hopkins, '20, March 19, 1971
Lawrence Castonguay, '21, March 24, 1971
William C. Colley, '21, January 10, 1971
Louis D. Striebel, '21, June 16, 1969
Charles Adamson Chase, '22, March 28, 1971
John L. Brill, '23, February 8, 1971
Frederic W. Guerin, '23, April 3, 1971
Frank M. Gorsuch, '27, March 22, 1971
Lee J. Schnackenberg, '29, March 8, 1971
Frederick J. O'Sullivan, '31, March 28, 1971
Henry Malin, '32, January 7, 1966
William M. Mahoney, '35, February 27, 1971
David E. Kenyon, '41, August 6, 1970
Guido J. Verrochi, '42, April 11, 1971
Frederick M. Newton, '49, January 30, 1971
Edward H. Andrew, Jr., '50, January 1970
*Further information in Class Review

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Class Review

95

A letter from Lester Steffens '30 told of his visit to **Luther Conant** at Christmas in 1969. Luther was happy to see him and most appreciative of his taking the time to visit him.

Lester mentioned Luther's sense of humor and the fine rapport between him and the nurses. He regrets he will not have the opportunity to visit Luther again.

My sincere thanks for the lovely note from the girls in the M.I.T. Student Placement Bureau.—**Andrew D. Fuller,** Secretary, 1284 Beacon St., Brookline, Mass. 02146

96

Dr. **William D. Coolidge** was the guest of honor of the Schenectady Museum at a reception which opened a new exhibit on "History of X-rays." Suspended X-ray tubes made unusual mobiles which were described by the chairman of the museum as "magnificently more intricate and beautiful than even Alexander Calder's fondest dreams." On behalf of Dr. Will, the vice president of General Electric presented the museum with a miniature replica of the famous Coolidge tube.

During spring vacation your secretary had a most enjoyable visit with Dr. Coolidge and herewith conveys his good wishes to all classmates—**Clare Driscoll,** Acting Secretary, #S304 800 4th St. S.W., Washington, D.C.

98

George Newbury is living with his daughter, Olive Buckley, at 525 Fourth Ave. W., Hendersonville, N.C. She sent a Christmas card, received in Mexico, with a nice note saying, "My mother died three years ago. My father is still very well but his memory is failing. He stays active around the house—saws the slab wood I buy for the fireplace and he keeps the fireplace going every day." The October-November issue of 1967 contained the story of his life which his son sent to me. I was happy to receive this current bit of news telling us that your classmate is well.—**Mrs. Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

02

It was pleasant to receive a letter recently from **Grant Taylor,** Clearwater, Fla. Grant took up residence in Florida in 1952 and took care that his home was so located that he had a good view of salt water—as he was a Rhode Islander that was most essential to make it more homelike. He reports that he and his wife remain close to their house and are never without a friendly helper. Although there is a local M.I.T. Club which serves Tampa, St. Pete, and Clearwater, Grant says he has never really been in touch with it. He sends his greetings to any inquiring friends. . . . Now let me hear from you.—**Burton G. Philbrick,** Secretary, Greycroft Inn, 68 Dane St., Beverly, Mass. 01915

03

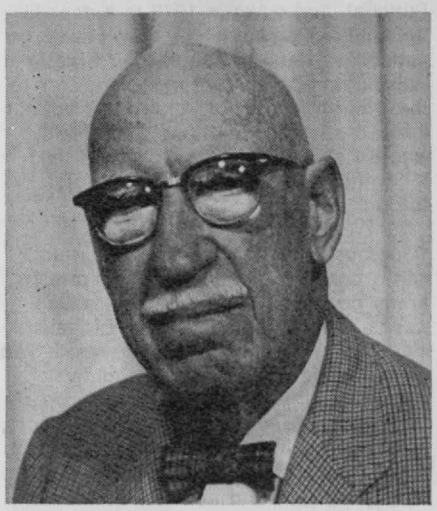
The increasing apathy of our mature yet still active classmates has been suddenly dispersed by a most cheerful letter from our active classmate, **Adolf E. Place,** 531 Ave. L, Boulder City, Nevada 89005. Adolf claims he is our oldest classmate, being 94 years and retired in 1960 and only hampered by natural ills of rheumatism and eyesight. However, he is a keen reader of all books, magazines and sundry newspapers but our M.I.T. *Review* is uppermost. Adolf notes he frequently corresponds with our classmate, **Charlie Cox,** 503 Orondo Ave., Wenatchee, Wash. who he states is still active in retirement.

Frederic A. Olmsted, 297 Miller Ave., Mill Valley, Calif., passed away September 21, 1970. He was active to the last and only spent a brief interval in the hospital. After graduating from M.I.T. Fred had a busy career as a chemical engineer with A. D. Little Co. in Boston, Mass. He then went West in his career, ending up as president of Hood River Spray Co., Hood River, Oregon before retirement. He was one of our active and loyal classmates until his fatal illness.

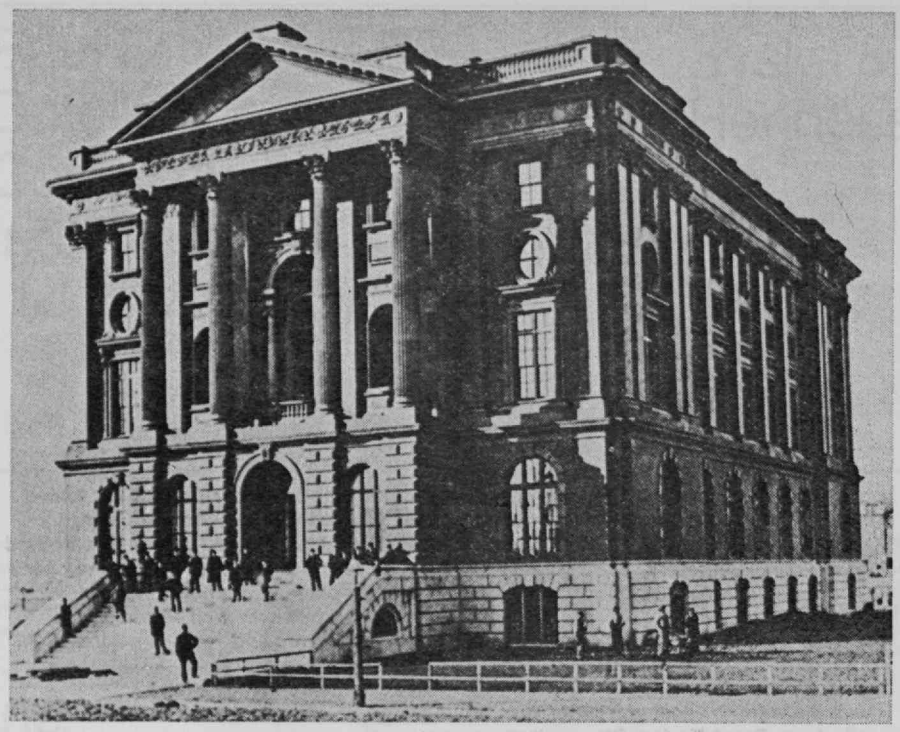
A brief note from our Councillor, **Ichabod F. Atwood** of Newtowne Farm, Topsfield, Mass. 01983 informs us he had hoped to make a Spring trip to one of his far away places but ended up in M.G.H. He is now however well rested at the farm and improving rapidly.—**John J. A. Nolan,** Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143

05

Lack of news caused me to draw a blank in the May issue, but fortunately a few classmates decided to "give," hence we have a bit of news for you here. . . . A short note from **Hal Robbins,** Course I, contained a picture which shows him in



good health, and he admits it. . . . From the same city, and same apartment center, comes a letter from **Roy Allen,** Course III, which I am sure you will enjoy: "I was doubly glad to receive the class register, for it told that many whom I knew at Tech, and of whom I have not heard, are up and presumably are going strong. A few I have run across at the few reunions I have attended. For example, as a small boy I lived on the same street, in the next block, as **George Prentiss** in Holyoke, Mass., but have seen him but once since graduation. That goes for several others. Last winter I was pleased to see in the January issue of *Technology Review* the tribute to our



Earliest known photograph of the Rogers Building, taken in 1872.

most distinguished classmate **Doc Lewis.** It also brought to mind other classmates in 'K2S' who made good: Willis Harrington, Walter Bent (and his brother Levett of '06) and Charlie Johnston. During the first World War, I was a captain in the Air Service (with my spurs and Puttees), tied down in 1918 to a desk in Washington, and unhappy. Doc Lewis and Billy Green on one of their trips to Washington persuaded me to transfer to the Chemical Warfare service. I tried, but instead was sent to the McCook Field, where I stayed until my discharge the following year. However, I was grateful to Doc.

"On your list of class survivors I note half a dozen of ex-course III, which is a pretty good percentage. It must be we were a tough breed. Grace and I feel we made a good choice in Orangewood. The residents were apparently carefully screened; all well educated and properly brought up—doctors, lawyers, professors, teachers, engineers, bankers, merchants, accountants, etc. By the way, a professor of mathematics and later on the official staff of the University of Montana, with his wife joined us not long ago. They knew Charlie Clapp and family when Charlie was president of the University. Mrs. Clapp died about five years ago. I last saw her when we called on her at Missoula in 1951." You are right, Roy; Course III has the best showing as regards members of the class still alive. Course VI pretty close.

Charlie Smart and Isabel are our greatest travellers, at least for the moment. He writes, "We returned yesterday, March 30, from a trip (two weeks) to New Orleans, Mobile, Alabama, McComb and Natchez, Miss., and found your letter of March 24 waiting for us. It was a cool but fine trip. We flew to New Orleans, by Greyhound to Mobile and McComb, rented a Ford and drove to Natchez. Then back to McComb, to New Orleans by Greyhound and home by plane." . . . **Bill Spalding,** Course III, complains about six inches of snow in one week. Sympathy, Bill and Alice. We had 140 inches with two flurries last week, which we don't count. Bill also half promises to visit us (and his brother in Fryeburg, Maine) this fall. . . . **Hub Kenway,** Course II, says he gets to the office regularly, but a bad back ties him to a cane, which prevents much travelling. He reports the recent death of his sister, Rosalind, who was Doc Lewis' wife. . . . **Sam Seaver** and Mrs. Seaver spent an enjoyable six-week vacation in Florida, with considerable betterment to their health. Sam is the only Canadian in our ranks today—has been there almost ever since graduation.

As far as I know, **Prince Crowell** is our only living yacht racer. How's this for ambition and vigor: "I just bought a hull of a new cabin cruiser plexiglass boat, and am finishing it here in my garage. If you were as old as I, you would see it takes time. You are right, if Andy was only here, he would be doing all, not 90 per cent of the hard work. I am planning to win this year and then retire and turn the new boat to my grandson. He won S.M.Y.R.A. this year. Got to keep it in the family. Ethel isn't very well. She had two bad falls last week but has lots of spunk." He refers, of course, to **Andy Fisher,** who was always there to help Prince get his fleet into the water. . . . **Chet Shaw,** Course VI, who has always bragged that anyone wintering in northern New England was a chump now brags about spending the last two winters here—a matter of circumstance apparently, all of which proves that he and Isabelle must be in pretty good shape.

After sticking it out all winter, Ruth and I are going daughter-visiting. Visiting daughter number 4 in Greensboro, N.C.; then daughter number five in Newark, Delaware; next daughter number two in Mountainside, N.J.; daughter number one in Boston and daughter number three in North Reading, Mass. Hope I have the numbers and routine right. Oh, yes, and a dozen grandchildren in all. Alumni Day comes early this year, June 7, perhaps before this issue of the *Review* reaches you. Ruth and I will be there and we hope to see a goodly number of classmates at our 66th Reunion.—**Fred W. Goldthwait,** Secretary, Box 32, Center Sandwich, N.H. 03227; **William G. Ball,** Assistant Secretary, 6311 Fordham Place, Bayshore Gardens, Bradenton, Fla. 33505

06

For members of '66 the *future* is where their interest lies but for us in '06 the *past* was important. How the memories come flooding back! It was sixty-five years ago when we gathered in Huntington Hall in the Rogers Building—over 400 of us—to yell "Blackie ist gekommst" as our beloved German Professor came puffing up the aisle. We didn't all get a sheepskin but we had had four, or three, or two, interesting and rewarding years together there on Boylston Street.

Remember sitting on those massive granite railings and steps on a warm spring day watching the gals go by with their skirts nearly down to the ground? Yes, the memories do come flooding back but what about *you coming back* on June 7? Can you, will you, won't you? Marion and I expect to attend the luncheon, at least, and of course a class meeting if our esteemed Class President, **Stew Coey,** wants one. If you are not expecting to attend our 65th please send a note or card to—**Edward B. Rowe,** Secretary, 11 Cushing Road, Wellesley Hills, Mass. 02181

07

The '07 class news column has reappeared! This month's issue begins again what we hope will be a steady stream of news for the members of '07. The initial response to **Jim Barker**'s letter to his classmates was very encouraging and we hope many more will write in.

Since it was Jim's inspiration that started the '07 news rolling again, we'll give first place honors to his news as follows: "The Class celebrated 1967 by holding a sixtieth reunion in June at McCormick Hall, M.I.T. Don Robbins, Phil Walker, Harry Hall, Hud Hastings and their wives joined Maud Parlin and her son, Stan Wires, Frank and Milt MacGregor, Kelly Richards, and Louis Freedman at a dinner on June 10

which my wife and I gave to the Class at the Faculty Club. Our only regret was that more members of the Class were not present, for it was a pleasant occasion.

"For some years we have made two annual trips to Europe, the first in July for a week or two with the Atlantic salmon on the Gloppen River halfway up the west coast of Norway, and then in August to Scotland for grouse shooting in the Highlands. I have always enjoyed shooting and fishing, and these particular excursions, while strenuous, are always interesting. In 1969, never having explored the Southwest Pacific, we spent a month in New Zealand, Australia, and some of the Pacific islands. Australia's Barrier Reef and New Zealand's mountain region in the south island are unique in their striking characteristics.

"As for business, when I decided to retire from my long-time responsibilities as an active director of Sears, Roebuck and Co. and of Allstate Insurance, the companies made me their first honorary director, which enables me to keep in touch with their remarkable progress. In 1969 I resigned as an active director of the Milwaukee Railroad after almost a quarter century of relationship to that enterprise. I have kept up with education and its problems as an emeritus member of the Northwestern University Board of Trustees and as an active life member of the M.I.T. board. The Institute honored me in 1970 by naming the Engineering Library under the dome for me.

"Both my wife and I have been fortunate so far as health is concerned. Eighty-five years exact their penalties, but we hope to keep going for some time yet. One of our close friends is Joshua Green, the Seattle banker, whose 100th birthday we helped celebrate in 1969. He is as active as ever, and we hope to follow his example. I have missed the Class Notes over the years since Phil's death, and hope that those of us who are left will make the effort to send in their news, confident that all of us will be interested, J. M. Barker."

One of the first to respond to the new appeal for news was **Milton MacGregor,** who stopped in the *Review* office recently and expressed his appreciation and anticipation of soon seeing news from his classmates. He writes: "Since my wife died in 1966, I have moved from Brewster, Mass., to the Baptist Home of Massachusetts in Chestnut Hill in the back yard of Boston College. I had a shock on June 10, 1968, but am largely over it. I have kept up my interest in the church where I was on various committees in Brewster." Milt is also interested in athletics: he bowls candle pins averaging 95, walks a great deal, jogs around the track at Boston College and climbs mountains. This last activity keeps him interested in the Appalachian Club for which he has worked for pay and voluntarily since 1915. He has climbed Mt. Washington three times in the last two years; one climb last October took him up Tuckerman's Ravine (a very difficult climb, I'm told) and all this at age 86! Milt continues, "Since coming to the Baptist Home I have taken up weaving. I received an apprentice rating in 1970 and a journeyman's in 1971 in the Boston Weavers Guild. I have acted as president and secretary of my Hyde Park high school class since 1953 and kept in touch with all living members (12) since that time. **John** 'Clem' **Bradley** and **Frank S. MacGregor** are members of that class. In September 1969, I married Ethel Hall and we are living 'happily ever after' in the Baptist Home."

John C. Bradley took a minute from his gardening activities to offer this welcome note: "A few months ago the hose Mrs. Bradley used to water the garden leaked so badly I gave her a birthday present of two long hoses. They are guaranteed to last 20 years. So, expecting to live as long as the hoses last, we continue to keep on gardening. She plans to have some special wild flowers in the woods back of the house, so I'm using the chain saw to saw up a big (dead) oak tree. She wants logs to give a proper setting for her planting on the slanting edges of wood paths.

"I've given up keeping bees. The old bee hives cluttered the cellar so much that four station wagon loads of hives have been removed. Some of them will be used by a 60-year-old, just retired, who plans to have bees for his hobby. I'm so glad James Barker found a way to get 1907 items into the *Technology Review* again! Best wishes to the Class Notes Editor."

Another garden buff, **Walter B. Kirby,** tells us of his latest activities: "First I wish to express my appreciation of your efforts to find a way of holding our Class together. The excellent work of our secretaries will always be held in warm esteem. My small contribution to your good suggestion, should be titled 'inactivities' rather than 'activities', as having past the mid-eighties, my arrows have long since been shot.

"In December of last year, I was taking my usual constitutional and unwittingly stepped upon some snow-covered ice. I had a bad fall, and the hospital X-rays showed a fractured right arm close to the shoulder, also an injured elbow and wrist, all of which are very slow in mending. To add insult to injury I came down with a bad attack of flu. Now I am obliged to have assistance with my annual activity of taking care of my fruit trees, vegetable and flower gardens, much to my disgust. My avocation of landscape painting is held up indefinitely. With my kindest regards to you and to my fellow architects of yesteryear. Very cordially, Walter B. Kirby."

We regret to report the news carried in a note from Mrs. Elizabeth Hull telling us of the death of her husband **Andrew W. Hull** on February 8, 1971.

Our sympathy is also extended to Mrs. Minnie Stow whose husband **James P. Stow, Jr.** died on February 8, 1966. Mrs. Stow adds in her note, "I certainly wish I could be of help to the Class of '07, for my husband thought a great deal of M.I.T."

We are also sorry to report the passing of **Floyd A. Naramore** on November 18, 1970.

E. Stanley Wires has answered the appeal for news with this interesting note: "Since my wife died about five years ago, I have lived alone at 367 Linden St., Wellesley Hills. I retired from my tile business at the age of eighty, but have kept up my interest in ceramics through my exhibit in the Smithsonian Institution and a small private collection of old decorated tiles. I never expected to live to such an age that letters are sent to me from museums, from Williamsburg, etc., asking for information about tile companies' products rated as antiques, that I did business with in my early days.

"Another project I have got involved in is genealogy. If any of you start looking up your family history be prepared to find out that one of your relatives in the third or fourth generation may have been a smuggler. For every ancestor you had that received honorable mention in battle probably at least three deserted after nightfall. I also have another interest—twenty-three children, grandchildren and great-grandchildren, scattered from Lexington to Scotland. Many birthdays to keep track of."

Several more letters were sent in just as we were going to press so we'll save them for the July/August issue. We are very grateful to those who have written in but we hope that the initial enthusiastic response to the plea for '07 news is not short-lived and that the '07 mailbag will continue to be well stocked for future issues. Send your news to Kathy Sayre, Class Notes Editor, Technology Review, M.I.T. E19-430, Cambridge, Mass. 02139

08

We have another report from a consulting engineer **George Schobinger** of 285 Swarthmore Ave., Swarthmore Pa. He graduated with '08, as a civil engineer and has handled big construction work in all parts of the world. Before going to M.I.T. he received his A.B. at the University of Chicago with senior honors in mathematics and modern languages, and Phi Beta Kappa; then taught these subjects while he studied law evenings. He ascribes his success in foreign countries to his fluency in talking their language, French, German, Spanish and Portuguese. He was awarded the "T" in track in 1908. First employed by the Board of Supervision Engineers of the Chicago Traction Co. designing tunnels and subways, he later became supervising engineer of construction bracing buildings for soft ground tunnels and

tubes under the Chicago river. For six years he was assistant engineer of the U.S. Bureau of Reclamation and took charge of the design and construction of a 1200-foot by 16-foot-diameter tunnel working under compressed air 40 to 45 pounds above atmosphere in soft ground 90 feet under the Colorado River at Yuma, Arizona. His paper, "The Colorado River Siphon" received the Collingwood Prize for Juniors A.S.C.E., in 1912. The remaining four years he worked on a drainage and canal system on the Colorado river in Yuma and later in New Mexico on the Rio Grande project. Then two years at Hog Island Shipbuilding Corp. Returning to Dwight P. Robinson Co. consulting engineers, he reported on an irrigation system for 200,000 acres in Peru. As hydraulic engineer he made studies, investigations, etc., on hydro-electric projects in east and northwest U.S. He designed and constructed five concrete dams for irrigation in northeast Brazil. Three years later he returned to New York, serving as chief draftsman to design and direct the construction at East Boston of a classification yard (a hump yard) for the Boston and Maine railroad. New work started in Argentina constructing the La Croze subway. When the Dwight P. Robinson Co. merged with the United Engineers and Constructors Inc., George served as engineering manager of this new organization. He was next assigned to locate and design five large railroad bridges on the Coatzocalcos-Campeche Railroad in Mexico. In 1938 he was appointed vice president of Ulen and Co. New York Engineers—designing and expanding a large industrial plant.

In 1940 he joined Day and Zimmerman Inc., as vice president and director to set up and organize an engineering design division as supplement to the consulting service that the firm has conducted for 50 years on economic and financial investigations. George acted as consulting engineer on the experimental atomic reactor at Geneva, Switzerland; his activities also included reporting to banking houses financing the St. Lawrence River and Niagara power projects. From 1956 to 1961 he served as consultant for the International Finance Corporation at Washington, D.C. on numerous power potentialities of the Republic of Viet Nam. In 1960 he spent three months directing the public works of the Kingdom of Morocco.

His consulting services for the U.S. Goverment and for private interest include work in Mexico, Costa Rica, Peru, Argentina, Uruguay, Brazil, Canada, Sweden, Sicily, Switzerland, Morocco, Liberia, Viet Nam, Thailand, Japan, and many of the United States, in which he was a registered professional engineer. George is a member of the Cosmos Club of Washington, D.C., the Meridian Club of Philadelphia, Aztec Lodge number three, Las Cruces New Mexico A.F. and A.M. He served several terms as trustee of the Swarthmore Presbyterian Church, and of the Swarthmore School District.

The Alumni Association reports only one change of address: **Charles A. Edmonds,** 7106 Leona St., Washington D.C. 20028. —**Joseph W. Wattles, 3rd,** Secretary, 26 Bullard Rd., Weston, Mass. 02193

09

During March, April and May a Musical Festival consisting of three concerts was presented in New York by M.I.T. musical organizations as a tribute to Dr. and Mrs. Killian on the occasion of his retirement as Chairman of the Corporation of M.I.T. As a further tribute, a presentation of the Silver Stein was made to Dr. Killian. **Tom Desmond** was honored by having been made Chairman of the Silver Stein Awards Committee. We wrote to Tom congratulating him and received the following reply from the Beach Club Hotel, Naples, Fla.: "Your recent letter did not reach me in time to meet your deadline for further information about the James R. Killian celebrations, but in some future 1909 class notes you can mention, if you so wish, that I have just received the 1971 Distinguished Amateur Award of the Horticultural Society of New York, citing my development of our arboretum at our home near Newburgh, N.Y., which arboretum now contains nearly 800 different kinds of trees and shrubs. In previous years I have also received because of this arboretum the large gold medal of the Massachusetts Horticultural Society and the Eloise Payne Luquer Award of the Garden Clubs of America." We have frequently mentioned Tom's arboretum in these notes and it's a great pleasure to the Class that he has received these well-deserved tributes.

From time to time in these notes we have written about **Elmo A. Robinson**'s career as a Universalist minister in churches in New York State, Pennsylvania, Indiana, Ohio, and California, and as a member of the faculty of San Jose College. Upon retirement thirty years later as Head of the Department of Philosophy, he became minister of the Unitarian Church of Los Alamos, New Mexico, where he is now emeritus minister. He has just sent us the announcement of his new book, *American Universalism,* which is an authoritative, objective account of the Universalist religion in America, 1793-1961, but embraces a broader range than that of any one religious group. According to the announcement it presents a fascinating segment of the religious climate of America beginning with the harsh life of the American colonists where hell, fire and eternal torment were the order of the day. This religious climate caused many worshipers to leave the church and paved the way for the Universalist religion based on the goodness of a living God. Professor Robinson traces the history of Universalism to its recent merger with Unitarianism. Included in the notice was a biography of Elmo's life. Elmo states, "we are off for my first trip to Europe," and on behalf of the Class we sent him congratulations on his book and best wishes for a well-deserved trip.

Members of the Class must already have received the elaborate notice and reservation application for the M.I.T. Homecoming, June 6 and 7, 1971. We hope that many of you will be present for that occasion and especially for the luncheon on June 7 when there will again be an opportunity to meet old classmates.—**Chester L. Dawes,** Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138; **George E. Wallis,** Assistant Secretary, Wenham, Mass. 01984

11

The following is from *Illinois Alumni News* for November, 1970: **Harold Eaton**

A gathering of 1912 classmates in Venice, Fla.: Standing: J. Lenaerts, H. Brackett, Miss Forbes, Mrs. Cooley, L. Cooley, Mrs. Lenaerts; sitting: Mrs. Wilson, A. Eicher, Mrs. Eicher, R. Wilson.

At the Noche Mexicana of the M.I.T. Mexico City Fiesta in March, J. A. Noyes, '12, seated between Jim and Mrs. Killian, this year's honored guests.

Babbitt, M.S.'17, Professor Emeritus of Civil Engineering and internationally recognized authority on sanitary engineering died October 10 in Seattle, Wash., where the Babbitts had lived since 1962.

After retirement from the faculty in 1954, Professor Babbitt traveled widely. In 1955-57 he was sanitary engineering educational consultant, U.S. Operations, in Brazil. In 1960 he went to Korea where he advised the dean of engineering of the University of Seoul, working under the auspices of the University of Minnesota. The following year Professor Babbitt was at the University of Roorkee in India under a program of the University of Wisconsin and the International Cooperation Administration. Between these assignments Professor Babbitt was a consultant on a Seattle Metropolitan District project, and was visiting professor at the University of Missouri and at Iowa State. His texts, *Sewerage and Sewage Treatment* and *Water Supply Engineering* have gone into many editions and he is the author or coauthor of a number of other publications.

Professor Babbitt was with the Chicago Sanitary District and the Ohio Department of Health before joining the University of Illinois faculty in 1913. A faculty member for more than 40 years, he also served 30 years prior to 1953 as secretary-treasurer of the Illinois Society of Professional Engineers. He was a past president of the Association of State Engineering Societies and had been vice president of the National Society of Professional Engineers. An honorary member of the Water Pollution Control Federation, he also was a life member of the American Water Works Association which honored him with its Fuller Award, and had been a director of the American Public Health Association. Also active in civic affairs, the educator had served as an Urbana alderman. Surviving Professor Babbitt are his widow, the former Elma Jones Benedict and four step-children.

About a year and a half ago, **Walter C. Wilson** of Andover suffered a stroke and is now able to get around with a cane but cannot walk far. From his recent letter: "I go to the factory every day for a couple of hours but do not do much except advise and consult. My son and my nephew, both graduate engineers, run the business and we have about 250 to 300 people on our payroll, making and selling metal products. We have one M.I.T. man with us. My son is president and my nephew is treasurer, and I am chairman of the board. My wife, Mildred, and I go to Delray, Fla. every winter for three months."

From Mrs. **William O. Whitney** of Dunedin, Fla.: "Bill has been suffering with arthritis so that he has been crippled and even now is recuperating from a foot operation." . . . **Eldred E. Besse** is recovering from a post-operative coronary and is looking forward to spending the summer at his place on Cape Cod. . . . By the time you read this our Sixtieth Reunion will be over, but look for Jim Duffy's account of it in the September Class Notes.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

DO YOU REMEMBER when President MacLaurin first assumed office at the Institute and gave a talk in the Union, telling us about his native New Zealand. Describing the natives, he said among many things, "The Maori is a friendly little savage." He could not have known why a loud laugh greeted these words, which was due to the fact that Fred Mowry was present as a member of our Class. Contributed by John Hall.

I am happy to report a special 1912 reunion in Venice, Fla. which was held by **John Lenaerts** and Marion at their new apartment. There were five couples present including **Arch Eicher** and Agnes, **Harold Brackett** and his niece, Eleanor Forbes, **Lloyd Cooley** and Treva (1911-1912), and **Ray Wilson** and Helen. Marion prepared a very special lunch, following which we went up to the patio roof where we enjoyed a view of the Gulf with the sun shining on heavy white-caps. A photo of the group is above. The time passed quickly with reminiscences of days at Tech and exchanges of current news of various classmates. Arch Eicher was en route from a vacation at Riviera Beach on Florida's east coast, to St. Petersburg and home. Arch was well-tanned and in improved health. The Bracketts were vacationing for a month on nearby Longboat Key where Harold is surf-fishing daily when not travelling about. The Cooleys have lived in Sarasota for several years and really enjoy Florida. Lloyd brought an old album which had a number of photos of Tech days. The Lenaerts are spending more and more time in Florida, but still take an annual trip to Cape Cod and New England in the summer.

Fritz Shepard writes from Boston, "This has been a long, hard winter—some eighty days with the mercury below freezing. You are fortunate to be in Florida. My arthritis is under fair control and I try to get out for a short walk every day.

"**John Raymond** tells me that he still gets into Boston for work with Metcalf and Eddy in Park Square four days a week, and usually gets his exercise by walking one way from the North Station. We see **Jerry Hunsaker** often. He is at his office on the campus every day. I hope the class members will continue to send in news of their activities as I greatly enjoy reading about what they are doing."

And a welcome note from another of our "regulars," **Jonathan Noyes,** who writes from Dallas, Texas, "Congratulations on the fantastic job you are doing! You must have a couple of well-trained blood hounds to track down all the old timers. Sorry **Jay Pratt**'s health forced him to resign. Hope that he and Priscilla will have a complete recovery. I was the only 1912 man to attend the Mexico Fiesta this March; 1912 was the oldest class represented. Also, my son Jonathan H., was with me and we were the only father and son team present—1912 and 1942. This was my second visit and John's third. We had a gay time. The M.I.T. group living in Mexico City roll out the red carpet and are true professional entertainers. There were Tech men and their ladies from coast to coast and from Canada. Next year will be our sixtieth class reunion and I join with you in the wish that most of our classmates still able to travel will make a real effort to be with us." . . . And that is all there is for this issue. How about it, fellows?—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

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You no doubt have received the announcement of the M.I.T. Homecoming Sunday, June 6 and Monday, June 7, 1971. Shall we see you in Cambridge at one of the various activities? Roz and I shall probably partake and we shall be looking for you.

We have sold our Canton property and our plans are beginning to gell. Roz will retire from Johns-Manville sales organization after 28 dutiful years. We shall move to Biddeford, Maine and await the construction of our "Retirement Home." It is always a pleasure to serve the M.I.T. Class of 1913 as Secretary and Treasurer, and we shall continue to hear from our friends and classmates.

It is with a heavy heart that we must report the departure of **William Newsome Eichorn** of 91 Beach Bluff Ave., Swampscott, Mass. He died after a short illness on April 14, 1971. "Ike" is survived by his dear wife, Dorothy (Hannan) Eichorn, also a brother, John F. G. of Largo, Fla., and a sister, Mrs. Gretchen E. Taylor of Boston. Funeral services were held Friday, April 16, 1971 at St. John the Evangelist Church, Swampscott, Mass. "Ike" was an outstanding athlete and played for two years on our 1913 class football team. He graduated in Course XI, sanitary engineering and practiced in that field. After a few years he entered the real estate field. To Dorothy, we offer our most sincere sympathy and her loss is our loss.

Note from **Laurence C. Hart,** "Arry and I are holding down the fort 'at home', and since we haven't had much winter to speak of, we have enjoyed being 'put'. Our heartiest greetings to all our friends."

We are looking forward to seeing you and yours at the 1971 Homecoming, and our 60th Reunion in 1973.—**George Philip Capen,** Secretary and Treasurer, **Rosalind R. Capen,** Assistant Secretary, 60 Everett St., Canton, Mass. 02021

15

The sympathy of our Class goes to 1924 for the sad loss of their popular and energetic Class Secretary, Henry B. (Chick) Kane who died recently. Do you fellows fully realize what a fine class crowd you really are? 56 per cent of our mailing list paid an average of $9.65 each for class dues—a truly splendid and remarkable showing. You must know I cannot answer every letter (but they will be in the notes) but I do thank each of you and I want you all to know I certainly do appreciate your generous and magnificent support of our Class. The dues solicitation coincided with Fran's and my annual Caribbean Cruise, resulting in several snide jokes about "timing." Well, the underpaid Class Secretary deserves a little "break"!

To continue our alphabetical news and notes. Mrs. **William Holway** wrote that Bill has had some serious surgery, with dacron patching of the aorta and two main arteries in his legs, but he is slowly recovering. Our sympathies to him and cheerful wishes for a complete and speedy recovery. . . . From Hollywood, Fla., **Larry Landers** wrote to Ben: "I usually get here about December 1 and stay till about April 10 or so, nothing exciting, just a few drinks here and there. I am on a semi-retired basis with my company. I just attend board meetings, when up north I go into office three days a week, hours 9 to 4—not bad." . . . **Joe Livermore:** "All is quiet here in the Ridgewood area but I'm still working and may actually retire as soon as the project is completed this spring. Marjorie and I celebrated our 50th Wedding Anniversary September 26 last. Our daughter June (whom you met last June) and our son Dick gave us a grand party with 60 friends coming from far and near. Then in October we flew down to Bermuda for a long week end. Our annual visit to Jamaica will be skipped this year, in favor of a month in Maine in August where our daughter and husband have bought a shore front place at New Harbor. Our oldest grandson, Tom Reid graduated from Yale in '69 was married and he and his wife are taking their doctorate degrees in ecology at Leland Stanford. Our next oldest, Joan is 21 and a sophomore at Oregon State. Then the other three grandsons 13, 9 and 6 are in school. Just to keep me out of mischief I am starting my fifth year as a member of the local Planning Board. We meet two or three evenings a month from 8 to 12 and try to keep the town shaped up. A very large wish for your good health and happiness."

Bob Mitchell, enjoying his retirement and family in Florida: "I spend November to July in Florida. Have a big garden which provides most of our vegetables; our waters supply plenty of fish. We usually have family visitors during winter school holidays—grandchildren, sometimes our children. We have a camper and often take them camping in some of Florida's many beautiful State Parks, usually down in the Keys or Everglades, where it is warm and the swimming good, and not so crowded. Anne and I usually take a trip to the Bahamas in November or December, exploring and beach combing; we take a different one each year. The Outer Islands are beautiful, uncrowded, unspoiled—some of the most beautiful sorts ever seen and a yachtsman's paradise. I have two grandsons in Cornell, one granddaughter in Skidmore, another into Cornell next year. One son-in-law is superintendent of Nuclear Physics Laboratory at Cornell; another Professor of Civil Engineering. The latter and family are on sabbatical in Switzerland this year. I get plenty of exercise out of my gardening, and have a little skiff—a delight to row—on our pond, which I use often, but I find each year that the joints creak if I work beyond the tired point, which is a half day. I am much concerned about the attitudes of many I meet, including my own grandchildren, but do not seem to be able to change anything. So just go on puttering, and muttering 'it's a crazy world!' " . . . **Herm Morse:** "With all the inflation you have done a good job in holding the line. We haven't done too much traveling but expect to go to Florida in March to stay until May 1. We have a condominium on Ormond Beach, one of the unspoiled beaches in Florida. A little too far north for all winter but ideal for spring and fall which as yet is as much as I want to be away. We have what we think is one of the finest great-granddaughters ever born, now just four months old and are lucky that she lives only 15 miles away. I hope I am right in thinking that there are some signs the pendulum of campus unrest is slowly swinging back from its extreme position. That and the fact that money for the schools will not be so plentiful in terms of today's costs may make for a return to sanity."

Poor **Boots Malone** in Umatilla, Fla. But happily, a later card from Boots said he was back on his two feet again. All the best, Boots: "I trust you and Fran have a wonderful time on your cruise. I have been out of circulation for the past three weeks—fell off my bicycle landed on my right hip. Fortunately no bones broken, but the nerves were injured and they seem very slow in recovering. So I have been on crutches!" . . . **Frank Murphy:** "This 63-day period of cold and snow has caused me to seriously consider moving to Florida where, while the temperature varies and is sometimes quite low, there is not so much snow to shovel." . . . Lucey and **Harry Murphy** ducked some of that snow by visiting their son Terry and his family in Albuquerque last winter. . . . Remarkable **Mary Plummer Rice** keeps going valiantly in her devoted work for U.S.O. "I returned Friday from a month's trip to the west coast—stopping in Dayton, Cleveland and Montclair on the way home—all in an effort to interest groups of women in the concern for the boys overseas, counting on the U.S.O. Clubs so far from home. Love to you and Fran. Hope you are both well. Remember you are the baby of the Class Supreme!"

Admiral **Bill Smith,** an ardent Red Sox fan is feuding with the management about the location of his season tickets. Better get a glove and bat, Bill and go out there and help them. . . . **Fred Stetson,** another Florida retiree: "I retired to Florida in 1959 and have lived a quiet life here since. For us, living conditions here are so good we wouldn't want to live anywhere else especially after reading about the snow and storms in N.E. and the Midwest. We do a little travelling, play some bridge and visit our grandchildren a couple of times a year. Best regards to the gang."

Ah, me! That **Jim Tobey:** "Enclosed is a contribution towards your next trip to Iceland, Ethiopia, or Mozambique. Sorry it isn't more. You will have to go steerage! Weather has ameliorated, so suffering less. Enjoyed your last class notes.

Best to you and Fran." . . . Now, here is the letter of all letters from **Ed Walker,** who gave us a KOZAK cleaning kit at our Fiftieth. His letterhead gives his unlisted phone number and he signs himself, modestly: "Bud Kozak, A.B. in Greek, Hamilton 1912, B.S. Electro-Chemistry, M.I.T. 1915; Doctor of Engineering, M.I.T. 1917; Radio Ham W2EE/4 old, old, old Timers Club. My first radio contact was in 1906! I am far better known generally as BUD KOZAK than E. C. Walker—as I have written the Kozak ads for the last 20 years before I gave the corporation to my children via inter vivos Trust some seven years ago, and retired. That was my pen name on many billions of separate insertions over the years. I came to M.I.T. as a graduate of the class of 1912 of Hamilton College—married and entered Course XIV which had only a dozen members, half of whom are now deceased. (XIV was then electro-chemistry in physics supervision.) I live in Florida saving $800 a year in N.Y. income taxes by moving! Last summer I went to Europe and visited Luxembourg, Frankfort, Zurich, Vienna, Venice, Capri, Naples, Sorrento, Rome and back to Florida one day before all the hyjacking! In May I leave Nassau for Luxembourg and a small town south of Koblenz where I have an apartment for six months, 50 yards from the Rhine and then back to Florida. I will buy a used Mercedes Benz and run around Germany and Europe with a chauffeur as I do not drive too well anymore—eyesight. But I do have an international operators license to drive anywhere. But those autobahns have *no* speed limit: 120-125 miles per hour is a little too fast for my age! So either the back roads or flying will probably be my cup of tea this summer." After that, I give up.

On April 16, 19 classmates and guests came to our Class Dinner at the M.I.T. Faculty Club. The four last minute cancellations would have given us a new attendance record. These staunch and stalwart long distance men won the honors: Larry Bailey and Ray Delano, South Duxbury; Whit Brown, Concord, Mass.; Jack Dalton and Pop Wood, Peterboro, N.H.; Charlie Norton, Martha's Vineyard; Ben Neal, Lockport, N.Y.; Harry Murphy, Hingham; Larry Quirk, Middletown, Conn.; and it was the first time in 35 years Larry had been in Boston. We were all glad to see him here. No greater interest and loyalty could any one ask. In addition to these were Clive Lacy, Horatio Lamson, Azel Mack, Frank Murphy, Wally Pike, The Pirate, and Bill Smith and younger members Jim Hoey, 1943 President, Gerry Rooney, and Bill Sheils. Surely a fine group to come out just to spend a convivial evening with old class friends—a fine crowd. The lively, enjoyable and enthusiastic meeting opened with the swashbuckling old Pirate's lusty and nostalgic cheer "We are happy." Cocktails and an excellent Bill Morrison dinner followed. Practically the only business was the announcement of our annual Class Cocktail Party, dinner and cordials at Bill Smith's, beginning at 4 p.m. on June 7 at the Faculty Club. Ben and Charlie stayed over with us—always welcome guests. Jack closed the evening with an informal but extremely informative talk about faculty and campus conditions currently at M.I.T. The lively questions put to Jack evidenced our interest in these situations. Many thanks, Jack.—**Azel W. Mack,** Class Secretary, 100 Memorial Drive, Cambridge, Mass. 02142

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As these notes are read, the 55th anniversary of our graduation will be history and the Reunion notes of June 8-9-10 at Chatham Bars Inn will be in process of preparation. We know it was a gala affair as always and hope you were there.

A letter from **Paul Austin** to Jim Evans from San Francisco reads in part as follows: "I have not retired, but am working for the Western Knapp Engineering Division of Arthur G. McKee and Co., Cleveland. Out here we specialize in nonferrous mining and smelting plants and chemical plants. Since last April I have been working outside our office on a joint venture with Bechtel on a copper mine on Bougainville Island. This is a $345 million investment. The copper ore will be mined and concentrated and shipped to Japan or Europe for smelting. For me, retirement is for the birds. I enjoy my job more than ever, and have many friends in the Bechtel organization where I worked for a number of years." . . . Jim Evans forwarded another letter, this time from **Buck Bucknam** expressing concern about Harold Dodge's illness and berating us for publishing some time ago a part of a letter in which he included the notation "Not for Publication." (Oh, come now Buck, I bet we didn't publish the part labeled that way. Try us again but without the restriction.) Watering the lawn and garden is a major operation in Auburn, Calif., where he lives, using Rainbow sprinklers five nights and three days a week with "Ditch water" which he buys by the "Miner's Inch", about 11.5 gallons per minute. He reports that he and his wife are in good health.

A letter from the daughter or **Freeman Clarkson** gives us the sad news of his death on February 27, 1971 of a coronary thrombosis at the Santa Monica Hospital in California. Her mother is also at the same hospital with terminal cancer and is not expected to live more than a few days. She writes, "There will be a memorial service for them both when I return the ashes to Newfane, Vt. on May 15, their 51st wedding anniversary."

A news release from the American Society for Quality Controls announces that a paper coauthored by **Harold Dodge** will be presented at the Silver Anniversary of the Society on May 19-21, 1971 at the Conrad Hilton Hotel in Chicago. An attendance of 2,000 is anticipated but unfortunately Harold will not be able to make the presentation as his doctor vetoes an effort of that magnitude at that time. The paper, "A System of Skip-Lot Sampling Plans for Lot-by-Lot Inspection" will be given before a session sponsored by the Society's Statistics Division. The paper outlines a system of skip-lot sampling plans, designated SkSP-2, for use in lot-by-lot inspections. It is based on the principles of the Dodge C.S.P.-type continuous sampling plans and provides for skipping the inspection of some of the lots when the quality of submitted product is demonstrated to be good. The basic scheme calls for normally inspecting every lot in accordance with a given "reference plan", but inspecting only a fraction, "f" of the lots when "i" consecutive lots have been accepted, and returning to every-lot inspection when a lot is rejected. The O.C.-curve and average-sample-size properties of the plan are developed, showing how skip-lotting can be used as a basis for "reduced" inspection.

A 3-column clipping which we have received from the March 26, 1971 issue of the *Harvard University Gazette* quotes Memorial Minutes from a meeting of the Faculty of Arts and Sciences relative to **Gordon Fair** who died in February 1970.

We received a nice long letter from **Allen Giles** which is regretfully briefed for the Notes as follows: "In October of 1966 I retired from Longwood Towers as Chief Engineer, after a most pleasant career of over 31 years, at the age of 71. My wife had been urging me to do so several years previously, but there was much to be done at Longwood Towers, and I had many lifetime friends there. We then did some of the things we had been planning to do at retirement, until May of 1968, when she was stricken suddenly with a massive coronary, and we lost her in less than four days. There was no previous warning. I found that the secret of finding a new orbit consisted in arranging a schedule of activity which demanded more time than I had. In February 1969 I read in the *Melrose Free Press* that an old-time engineering friend and associate at Stone and Webster had passed away in Clinton, Conn. I immediately wrote his widow, Mertie Louise to offer her any consolation she might need, and over a period of about a year, we decided that we would carry on as a married couple. We were married in Madison, Conn. on April 11, 1970 and went to Bermuda on a very happy Honeymoon. All of our families are most congenial, and we are enjoying our life together tremendously. We are planning to attend the 55th Reunion, and are looking forward to have you meet her, and I'm sure that she is equally anticipating meeting the members of the Class of 1916, which I have already told her is just the best Class that ever graduated from M.I.T. The picture of last year's reunion at Chatham Bars Inn was most nostalgic, and we are grateful to Ralph for sending it to us. I have already told Bob O'Brien on my return card that I am bringing my music, especially 'Old Man River' for Barney Gordon, so that if he is so inclined, we can provide incidental music for the 'Cocktail Hour'."

Allen also sends a news clipping noting that he received the Veterans 50-year medal for continuous membership in his Masonic Lodge: "Mr. Giles, who devoted 25 years from 1931 to 1956 as a Melrose public servant, was a member of the Board of Aldermen for ten years, and its president for one term; a member of the Planning Board for ten years, and its chairman for four years, and a School Committee member for four years."

A letter to us and a card via Jim Evans from our current round-the-world traveller **Charlie McCarthy** indicates that he is having a ball. He wrote to Jim: "The eyes of Kathmandu are on you. Having a great trip. Leaving for Delhi, India tomorrow and then on to Tehran, Iran. Will have many yarns to tell when we meet again.

"Betty and I have had a wonderful trip and praised be, have survived a series of different countries without being laid low. Found both Japan and India of great interest although they are completely different in feeling. After a month in Rome we arrived here (Taormina, Sicily) yesterday afternoon after a one-and-half hour scenic trip by car from the airport at Catania. It is well worth the trouble to come here. The hotel is old but attractive and perched on the side of a steep hill overlooking the sea—about 500 feet (I guess) below. The lobby on street level, is at the top of the hotel and our room is on the front of two floors below. Weather is perfect. We have just enjoyed a fine luncheon basking in the sun on the terrace of the hotel. I believe I could learn to like living hereabouts. From here we go to Naples for about a week, then on to Yugoslavia, Prague and then to join a tour in Moscow. We'll be back home May 1, if all goes well. Will try to attend the May luncheon meeting in New York if I have the strength."

A post card from **Herb Mendelson** from New Zealand dated February 17 gives a reaction to that part of the world: "This is a marvelous country, pastoral land 70 million sheep, 2.5 million people. Rugged mountains and fiords, plains and neat farms. No very rich, no poor, just great people. No tipping."

An April 14 clipping from the *Washington Post,* sent us by Alvin Guttag, '40, tells us of the death of **Dexter North** and goes on to say "a retired chemical engineer for the Central Intelligence Agency, died Sunday after a stroke, in Ridgefield, Conn. He was 80. Mr. North retired in 1956 after 20 years with the C.I.A. He had previously worked with the Tariff Commission and for Arthur D. Little. A native of Massachusetts, he was a graduate of Hamilton College in Clinton, N.Y. and of M.I.T. A specialist in genealogy, he was the author of several books on the subject. Mr. North lived in Washington until about two months ago. He belonged to the Cosmos Club. He is survived by two sisters, Mrs. Horace H. Jenks and Gladys North, both of Wilton, Conn."

We regret to report the death of **Al Lovenberg** on April 2 in La Jolla, Calif., where he and Frances had gone to live with their daughter Helen, when they moved from Springfield, Mass., following Al's severe heart attack in 1967. Since 1930 he had spent his professional life designing heating and air-conditioning systems for many types of buildings. In Springfield, he taught air-conditioning in trade extension courses in the Adult Education Division of the Springfield School System, and just couldn't resist more teaching of air-conditioning in the university after he settled in La Jolla. He was a consistent attender of 1916's 5-year reunions and with Frances took an active part in our 50th in 1966. His daughter, who is secretary of the International Center of La Jolla and active in the building of an International Center on the campus of U.C.S.D., writes that last fall she was fortunate in being able to join her father with Mary and **Joe Barker** at the Beach Club in La Jolla, where the two "boys" were resplendent in their bright red 1916 blazers. She hoped we'd pass on the pleasant memories to her father's many friends and classmates and in June "raise a glass to a devoted grad at Chatham Bars Inn."

A note from Mrs. W. W. Dodge tells us of the death of **Bill Dodge** on February 21, 1971. "He had not been well for two or three years after a severe operation but failed rapidly after Christmas. He was always interested in M.I.T., particularly those in his class and those in architecture. Bill retired in 1961 and lived a quiet life here on the farm. (It used to be a farm when we raised cattle, but now it's just a pleasant place to live.) We have two children, Nancy (Mrs. Peter Holloway, 2nd) and Bill 3rd, who like his father, is an architect in Raleigh, N.C. Three grandchildren and me comprise the family."

In conclusion your secretaries thank all our correspondents for supplying news of themselves and other classmates and urge you to keep it up—write little or much according to the urge, but write often to: **Harold F. Dodge,** Secretary, 96 Briarcliff Rd., Mountain Lakes, N.J. 07046; or to **Leonard Stone,** Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

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As these notes are being written your Secretary is on his way to the sunny south, after having supplied your Assistant Secretary with a good many news items on which to get his feet wet. We are indebted to **Bill Hunter** for sending in a clipping from the *Hartford Courant* of March 21, part of a separate section of that paper devoted to the town of Enfield, Conn. The clipping, which has a picture and an article about **John M. DeBell,** bears the heading "Ex-Industrialist is Vital Force." Both the picture and the article make clear that John has changed little since the days when he was elected editor-in-chief of *Technique* 1917. In describing his activities as vice president of Social Services, Inc. and his efforts to provide a building for the Mental Health Clinic the article states, "Like everything DeBell is interested in, growth and a positive constructive program to benefit man was involved." John retired recently from DeBell and Richardson, the company he founded shortly after World War I, but his activity along many lines continues.

Tom Meloy has written in about the sale of his company Melpar, to American Standard, and his activities since then. He succeeded in purchasing the Melpar Environmental Sciences and the Life Science Laboratories and the Special Products Division in June of last year to form a company known as Mel-labs, Inc., but soon to become Meloy Laboratories, Inc. He states that the good results have exceeded his expectations, and that he inherited a fine group of people who are working with him in "two pretty glamorous fields—cell biology chemocarcigenesis and environmental control and abatement." He also states that for reasons he does not understand his energies and health are "excellent", as reported after a recent physical examination. Obviously, congratulations are in order.

Ed Aldrin, despite his broken wrist which seems to be mending nicely, made it to New York for the April '16-'17 luncheon at the Chemists' Club, at which Dr. Stratton was able to give us a most interesting account of the many factors which were taken into consideration in the choice of Jerome Wiesner as president-elect of the Institute and Paul Gray as chancellor-elect. In the absence of Len Stone '16 who is on St. Vincent in the Caribbean, his class was represented by Walter Binger, Rudi Gruber and Frances Stern and representing '17 besides our honorary member and Aldrin, were Enos Curtin, Clarence Seeley and your Assistant Secretary.

Pat and **Bob Erb** have supplied an interesting report on their most recent excursion to the east and north coasts of Africa, as follows: "We took a four-week camera safari with another New Canaan couple, starting from Nairobi on January 15. We had an excellent courier who had complete knowledge of the area—the animals, the birds, and all the wild life. We combined a Toyota Land Cruiser and a chartered two-engine six-passenger plane to cover the most important national parks and game preserves in Kenya and Tanzania (Tsavohest, Amdoseli, Lake Manyara, Ngorongoro Crater, Serengeti, Masa Mara and Lamburu). We visited the Mount Kenya Safari Club (Hollywood in Africa) and spent a night at the famous 'Treetops.' The East African trip concluded with a three-day canoe-safari down the Tana River. A 'white hunter' was our guide and protector. There were eight natives poling and paddling the canoes and a crew of six set up camp

for us where we slept each night. When the canoes started down the river each morning, the camp, consisting of sleeping tents, dining and drinking tent, shower tents and toilet tents, would be moved to a predetermined location where we arrived late in the afternoon. It was hot on the river—105 to 110 degrees Fahrenheit! (We really prefer the ease and comfort of the national park lodges.)

"After the East African safari we flew to Rabat and spent a week driving around Morocco—Fez, Marrakech, Casablanca and Rabat. Beautiful country and friendly Arabs. We came home with excellent Nikon pictures which, combined with similar photos taken in 1969, will always bring fond memories of Kenya, Tanzania and Uganda. There were many more tourists in 1971 than in 1969. We recommend that anyone considering a safari should make plans soon—before the national parks are much too crowded and spoiled. As always, it was *good* to get back to New Canaan, Connecticut."

Tubby Strout, than whom no one makes better arrangements for reunions, comes up with a timely reminder about 1972. We quote: "Just a year from now we'll be getting ready to celebrate our 55th! Present plans should assure us of having as successful a reunion as we had in 1967. We'll start on Friday afternoon June 2 (a week earlier than it used to be) at Chatham Bars Inn which is just as lovely as ever. In fact, even more so, as many of the older cottages have recently been remodeled and modernized, and it's under the same owner management. On Saturday we'll have the clambake at noon and the big banquet in the evening. Further activities will be announced later. On Sunday we'll finish up early enough to permit participation in the Homecoming events in Cambridge that evening and on Monday, June 5. . . . Please put these dates on your calendar now so that nothing will interfere or prevent your being present."

If 1972 and the 55th seems a long time off and you're impatient, don't forget the 54th, which will again be at the Northfield Inn, Northfield, Mass. on October 6 and 7, 1971.—**Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th Street, New York, N.Y. 10028

18

Since writing last month's notes, the M.I.T. Corporation has chosen Dr. Jerome Wiesner as its next president and Professor Paul Gray as chancellor. They have our best wishes and congratulations. In turn, M.I.T. is to be congratulated on having this capable team to lead the Institute through the difficult tasks facing it. We hope there will be opportunity for these new leaders (perhaps through parlor meetings) to meet many of you in smaller groups.

I am particularly impressed with the loyalty of our classmates to M.I.T., as you will see reading through this month's correspondence. In particular, **Al Walker**'s note which follows immediately, makes one ponder. How many of this generation would get up at 3:30 every morning to deliver newspapers to satisfy a dream—to attend the finest engineering school in the country? I wonder? Here is Al's letter: "Dear Max: You might be interested in two rather unusual recent experiences of mine. The M. W. Scott Co., who sell grass seed and lawn materials, put out a bulletin for the summer of 1970 in which there was a discussion of atmospheric pollution. In this they included carbon dioxide. I objected to this because of experimental evidence in my Yale Ph.D. thesis for 1923, on the subject: "Equilibrium in Aqueous Solutions of the Alkali Carbonates." In a letter to the Scott Co., in September 1970 I pointed out that the waters of the earth could absorb all excess carbon dioxide effluents over the amount which has been in equilibrium in the air for centuries. I had some previous correspondence with Mr. Paul C. Williams, Chairman of the Scott Co. . . . Consequently I got a letter . . . asking for a copy of my thesis and offering to pay for it . . . a photostat copy of this 125 page thesis would cost about $20. When I advised Mr. Williams of this cost I got a check from him for $25.

"In the meantime, I had sent one copy of my thesis to a professor in a Friends School in Philadelphia, as a result of a discussion of atmospheric pollution at last summer's session of the New England Association of Chemistry Teachers, of which I have been an honorary member since the '50s. . . . The Philadelphia professor returned my thesis, so I sent it to Williams and . . . returned his check for $25. After he had his experts read it, Mr. Williams returned my thesis and asked for the name of my favorite charity, to which he could send a check for $25.

"I had just received a letter from M.I.T. Alumni Association advising me that a fund had been set up in the name of Professor Warren K. Lewis, and asking for contributions. You may not know anything of this, but I entered M.I.T. in the fall of 1917, with only a little over two years' credits from the University of Colorado. I had worked for about two years in Denver, Colo., as a stenographer, after graduating from high school, and during summers while attending the University. Also during many years of this interval I got up at 3:30 every morning and carried newspapers to save up money to complete my childhood dream of attending, at some time in the future, M.I.T., the finest engineering school in the country. Arriving in Boston, with no preliminary correspondence with the Institute, and with only enough money to tide me over for about one year, Doc Lewis and Professor Henry Fay were kind enough to arrange for me to take some special exams to make up credits I lacked, so that I was able to graduate in 1918 as a 'Maverick' engineer. Then Doc Lewis gave me a job, along with Howard Cyr, working in an attic in Boston on a government project of making a gas mask to stop poison smokes. Consequently I have a very warm spot in my heart for Doc Lewis. I wrote to Mr. Williams telling him something of my background and suggesting that he send his $25 check to the Lewis fund. The reply I got from him simply took my breath away. He advised me that he had sent a check for $250 to the Warren K. Lewis fund in my name!

"My most recent experience is also heart-warming. The other day a little girl came to see me and asked about my synthetic piezoelectric crystals. After giving her a brief story of my pet subject she asked, with considerable shyness, but also with unusual courage, if I would give my talk before her 5th grade class in a Millburn school. She called up yesterday asking me to give the talk that morning. It took some time to get my material, and movie, together, but I managed it. I was met in the hall of the school by this little girl, who proudly introduced me to her teacher and class. Then she got together another 5th grade class to attend my talk. After the meeting, at least 20 of these children came up, shook hands with me and thanked me for a most interesting talk. When I asked if they understood what I said about growing crystals they nodded most enthusiastically. Some delay occurred in the departure of the school bus, by the children talking to me. The biggest thrill I got out of this episode, was to see the courage and ability of this little girl in arranging for me to give this talk. With best regards to you and other eighteeners, Al Walker."

Here is a welcome note from **Gretchen Palmer.** (We look forward to seeing you on June 7, before these notes will be in print.) "Dear Selma and Max: Just a line to let you know that I am going to be at M.I.T. on June 7. Will be at the graduation at the University of Rochester to see Worthen Proctor's (Class of '17) son get his degree from their College of Engineering on the 5th and then on to Boston. It will be wonderful to be with the group again. I miss you all very much being so far away but that may not be for too long. My friends are urging me to come back east and they are trying to make it possible. Is there any idea when our 55th reunion will be as yet? Will be looking forward to seeing you in June. Sincerely, Gretchen."

A most interesting note follows from **Harry LeVine**—and again we will see him at M.I.T. Homecoming June 6 and 7. "Dear Max: First I would like to tell you that I read your '18 reports in *Technology Review* and find them all very informative and interesting. The thought occurred to me that it is about time for me to add a little information about the doings of my family, which I hope you will find worthwhile.

This photo taken circa 1918 shows Frank C. Burke, '18, (right) but can anyone identify fellow classmate on the left?

"My wife Eva and I have just returned from a month's visit to California where we went primarily to celebrate my 75th birthday on March 2 with our family. Our son Burton M.I.T. '49 lives there, and our daughter Rhoda whose son completed his bachelor's last summer and is now on his master's. His name is Neil Colvin. Our son Burton is engaged in computer science and electronics research, and fortunately, in spite of the countless unemployed, especially in California in the area of electronics, he has been steadily employed. Neil did what has been done for ages. He met a girl who is a 1970 Wellesley graduate, and has decided to marry her. The wedding takes place on June 8. We are of course planning to come and expect to arrive at the Fenway Cambridge Hotel on June 3, where I plan to attend the activities on Sunday June 6 and at least part of the activities on June 7. But since the wedding takes place on June 8, I do not know just how soon we will have to leave on the 7th.

"As for our trip to California, I followed my usual procedure and took in all M.I.T. events in the area while we were there. Just prior to our leaving here I was contacted by Harry Foster from Cambridge about the possibilities of setting up a seminar here on "How to Start a Small Business." I was awaiting further information when I learned that a seminar was being conducted in California at the Royal Coach Motor Hotel on Saturday, March 20. I went as an observer, and my son registered. There were about 100 who registered and attended the full program, and the quality, efficiency, and entire project were highly praised by all those who attended. The next day I attended a board meeting of the Southern California M.I.T. Club in the Roger Young Center in L.A. They conduct a fine well organized meeting, and seem to be progressive and extremely active.

"As for my activities here, as you know I have been regional manager of the Education Council for the past five years or so. We now have 15 counselors who are located all the way from West Palm Beach to Key West. We learned that in 1970 there were 4284 final applications as against 3402 in 1971, just announced. This drop of about 23 per cent is of course very disturbing to all of us, but other major universities are having similar experience. I must brag however, by informing you that we had 42 final applications in 1970, a goodly number from this area. We again had 42 in 1971, and while we had 14 admissions in 1970 we had 19 in 1971, an increase of 35 per cent, so I feel we are running ahead of the country as a whole. We are now highly concerned about the number who can meet the financial requirements and who will register, now that they are admitted, since there has been a sharp cut-back in the amount of financial aid available. I guess that brings you up to date for now. My wife and I shall look forward to seeing all of you in Cambridge in June. With warm regards from Eva and myself, Harry C. LeVine."

We have a letter (via Len Levine) from **Frank C. Burke** who enclosed the above photo. "Dear Len: I was pleased to have your note. I realize that I have never been a very enthusiastic alumnus, but the truth is that I have really no sentimental memories of the dear dead past. You may remember that until after 1918 the department of architecture was still in Boston, the old Rogers Building and that we had almost no contact with the rest of the Institute. I knew practically nobody in the class outside of Course IV. The names in the class notes are those of strangers for the most part and mine would mean nothing to them. I am at the moment retired. My old job ended in 1969 when the firm dissolved. I have since worked off and on (now off) for R. B. Wills Assoc. which is carried on by Richard Wills and partners. This job may or may not revive.

"I enclose some photos which I hope will interest you. Note the different dress of students then and now—hats, haircuts, collars and ties, coats and even vests. Could we have been the same age as the wierdies in the colleges now? I was delighted to read in this morning's paper that a student at the Institute got a year in the pokey for battering down the door of the dean's office. It took the court to do it; the faculty seemed to be in sympathy with the young rebels. I can think of no activity of mine which would be of interest to 1918 at large. I think that you are wise to continue in some activity and wish you well in whatever you may have in hand. Very sincerely, Frank C. Burke."

Leonard Levine has done a magnificent job in helping to secure material for these notes. We have asked him, and he has accepted the responsibility of Assistant Class Secretary.—**Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine,** Assistant Secretary, 3 Greenway Court, Brookline, Mass.

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Genevieve and **John Stevens** had dinner with the Smoleys late in March at the Ocean Club of Florida in Ocean Ridge near Boynton Beach. John has been taking things easy, plays some golf, is in excellent health. It was decided that all roads lead to our next 1919 reunion.

A letter came late in March from **Lou Grayson** correcting his address to 2000 L Street N.W., Washington, D.C. 20036. His residence is 2914 Glover Drive, N.W., Washington, D.C. 20016. He says "I'm semi retired, but shall probably be entirely retired the end of this year. You may recall that my wife passed away just two years ago. In September I married a good friend of ours (for 25 years) and we are very happy together with much traveling. Last fall we spent several weeks in Spain and Portugal and a couple in New England. The next will be to St. Croix, Portugal and a week at White Sulfur Springs. All good wishes."

Best wishes to the Class for a pleasant summer. Your secretary will be north from June 1 to November 1.—**E. R. Smoley,** Secretary, 50 East Road, Delray Beach, Fla. 33444 (Tel: 305-278-4537)

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Pleasant and gratifying is the news that our **Lauren Hitchcock,** Professor of Engineering at the State University of New York at Buffalo has been named the 1971 winner of the Professional Achieve-

Those in the Class of '20 will have no difficulty identifying these prominent members of the Alumni Advisory Council snapped at a recent council meeting while engaged in serious "counselling." On the left is, of course, our invaluable Class Agent and 50th Reunion Treasurer, Al Burke. On the right—now, just a minute—is that our other Class Agent, Perk Bugbee, or could it be his twin, the Class Secretary?

ment Award presented by the Western New York Section of the American Institute of Chemical Engineers. Dr. Hitchcock joined the faculty at Buffalo in 1963. Before that he taught at University of Virginia where he organized the first professional course in chemical engineering there. Previously, Lauren was associated with Hooker Chemical Co., Niagara Falls, and was vice president of the Chemicals Department at Quaker Oats Co. of Chicago. He also served as president of the Air Pollution Foundation, Los Angeles, and of National Dairy Research Laboratories of New York.

He was at one time a senior partner of Hitchcock Associates, consulting engineers, New York City. At Buffalo, Lauren has been director of the University's instructional television program for graduate engineering and management courses which telecasts engineering courses for local industry. Our distinguished classmate has published some fifty articles in technical journals. The citation for the Award covers the T.V. educational program and other graduate courses for New York management and engineers, and for his work as chairman of the Erie County Health Department Technical Advisory Committee which drafted the first air pollution control code for the region. Lauren's address is 800 W. Ferry St., Buffalo.

The A.S.M.E. publication *Mechanical Engineering,* lists among its transactions a compendium of managerial progress in the sixties by **Harold Smiddy** who is now an executive consultant in New York, after a long and distinguished career as an executive with General Electric Co. Harold cites some notable progress in this decade, including the N.A.S.A.'s decentralized approach which landed men on the moon; multinational firms spreading widely from numerous nations; the U.S. economy functioning at substantially a trillion dollar annual level. He mentions, also, some drawbacks, namely the regional, racial and religious conflicts resulting in spreading violence on campus and streets, overtaxed political leadership, and inflation, varying only in degree in both old and "new" countries. Harold resides at 30 Sutton Place, New York City.

As you read these notes, our indefatigable president, **Norrie Abbott** and his Betty will be dashing about Spain and Portugal in a drive-yourself car. Before returning, they will be stopping in Madeira and the Azores. We shall be sorry not to see you on Alumni Day, Norrie and Betty. . . . And speaking of Alumni Day, we trust the news in the next issue will contain a report on a goodly number of classmates in attendance, renewing pleasant memories of our happy 50th and envying somewhat the activities of that extra fine Class of '21. Oh, well, we're that much closer to our 55th, so take good care of yourselves and resolve to be present and accounted for four years from now. Meanwhile, your secretary hopes very much to hear from you.

As we go to press comes a welcome letter from **Fraser Moffat** who says he has gone "back to work in my garden and running the Country Club in Montrose, Pa." Fraser writes: "I have noted your complaint about the shortage of news in the 1920 column and can sympathize with you fully in that respect as I have the same trouble with the Class of 1918 at Williams." Fraser has been longtime secretary of his class there. Like so many of our classmates, Fraser wintered in Florida, at Vero Beach and at Mountain Lake, Lake Wales, where "I can report that my 1920 blazer made a big hit in the resort areas." While at Mountain Lake, Fraser got together with other M.I.T. men of long standing there, George Duryea '17 and Carleton Blanchard '18. The three of them took time off from golf to have a luncheon meeting with Hugh Darden of the M.I.T. staff, a delightful interruption of their usual golfing and sunning, according to Fraser. The Moffat address up there in the Pennsylvania mountains is 18 Lake Ave., Montrose.—**Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

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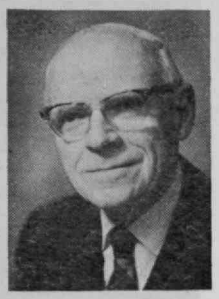
As you read these words, our stupendous 50th Reunion will be a shining memory for all who did "Join '21 in 'Seventy-one!" If you were there, you know what an outstanding job was done for your continuous pleasure and entertainment by Reunion Chairman **George A. Chutter** with the able assistance of those loyal and faithful members of his committee, including **Ed Dubé, Bob Haskel, Sumner Hayward, Chick Knight, Al Lloyd, Bob Miller, Paul Rutherford, Ted Steffian** and **Royal Wood.** If you weren't lucky enough to be present to help celebrate the event of our lifetime, you may derive some consolation by reading about it in the second following issue of the *Review*—newly-announced for appearance in September. We'll welcome your letters, whether you wish to compliment the group that did all the hard work in your behalf or to tell them how sorry you are not to have shared the unusually good fare they provided.

Another 50-year flyer

"I Flew in a Rubber Monster" is the intriguing title of an article in the April issue of *Yankee Magazine* by **Alan L. Morse,** 3337 Pinecrest Rd., Indianapolis, Ind. 46234. Alan tells of his experiences of 50 years ago as a Navy balloon trainee at Wingfoot Field, Akron, Ohio. He describes the crew's terror on starting their first flight and says when they did relax to enjoy aerial navigation, conversations from the ground could clearly be heard while the craft was silently gliding over Ohio farmlands and villages at 2800 feet. Readying for descent, they were shot at by a farmer. He resented having a chicken coop smashed by a chimney from the farmhouse which the balloon's trailing line had lassoed. Then the line's entanglement with a speeding train was barely avoided before landing was accomplished near a rural railroad station, where the "rubber monster" was deflated and shipped back.

Alan is a free lance writer and flying enthusiast extending a 50-year career which included experience as a Navy test pilot and flight engineer. We wonder whether he knew the late **Herbert V. Thaden** in the early '20s when Herb was piloting balloons in cross-country National Balloon Races. Alan and **Percival B. Crocker** of Foxboro, Mass., whose outstanding flying record appeared in last month's Class News, are the only known 50-year flying veterans in the Class of '21 unless **Daniel P. Barnard,**

P. B. Crocker, '21



R. D. Cooper, '21

4th, Dayton T. Brown, S. Paul Johnston or someone else can qualify. We invite correspondence on the subject.

How old was . . . ?

"I have just received the April issue of the *Review*," writes **Whitney H. Wetherell,** 1 Russell Dr., Harwich, Mass. 02645. He continues: "I see in your Class Notes that I enjoy the 'distinction' of being the youngest member of the Class of '21. I certainly need all the distinction that I can get, but I didn't quite make this one! A very talented and admirable young man by the name of **Walter J. Hamburger** put in his appearance on this earth 11 days after I did. There may possibly still be others who arrived even more recently!" Thanks, Whit. We didn't expect that you would be the one who would answer our challenge. Anyone else want to argue the point?

Mailbox miscellany

Our 50th Reunion brought up many memories of undergraduate days. The latest we have received is a photostat of a portion of the program for "Technology Night at the Pops, Symphony Hall," dated June 8, 1921. It bears the complete words of "A Stein Song," "Take Me Back to Tech," and "Dear Old M.I.T." This interesting piece of memorabilia was sent by **Philip R. Payson,** 5031 Northampton Dr., Tanglewood, Fort Myers, Fla. 33901. . . . In the same vein, **Philip A. Nelles, Jr.,** 21 Sunset Rd., Stoneham, Mass. 02180, writes that he mounted on a board a four-foot-long picture of the entire Naval unit at M.I.T. as the group was photographed in 1918, with a number legend for identification of individuals.

Arthur G. Wakeman, 130 Limekiln Dr., Neenah, Wis. 54956, reports a winter address at Bermuda High, Apt. 1-C, 2075 S. Ocean Dr., Delray Beach, Fla. 33444. He retired in 1963 as vice president for operations of Kimberly-Clark Corp., Neenah, of which he is a director. Art serves as consultant for government and other agencies on paper technology in addition to various directorships. He and Lorraine have a married daughter, a Smith alumna, and three grandchildren. . . . **Asher Z. Cohen,** who retired from the Army in 1956 with the rank of colonel and from the Department of Defense in 1966 as project manager, Edgewood Arsenal, reports he has spent several years as a S.C.O.R.E. volunteer for the Small Business Administration and received the "Volunteer of the Year" award for his work on counseling in business, engineering management, production and procurement activities. He remarks: "In the past few months, I have been saddened by the number of engineers and scientists, with bachelor's to doctor's degrees, seeking counseling because of loss of jobs. What a waste of human resources!" He and Clara spent the winter in Hallandale, Fla. and have returned to their home, Apt. 1-A, 3505 Langrehr Rd., Baltimore, Md. 21207.

International honor

Fellowship in the International Academy of Management, an arm of the International Council for Scientific Management (C.I.O.S.), headquartered in Geneva, Switzerland, was conferred upon **Saul M. Silverstein,** who retired in April as chairman of Rogers Corp., Rogers, Conn. 06263. Saul then spent six weeks in England, Belgium, Israel, India and Japan on a new life of travel, management consulting, writing and lecturing. He returned for our 50th Reunion and is embarking on another foreign tour that will include an international meeting in Malta to consider oceanographic matters. Saul served as Rogers' president for 20 years and for the last five years had been board chairman. He had also been vice president and secretary of the Council for International Progress in Management, the U.S. affiliate of C.I.O.S. He is the recipient of many honors from management and labor here and abroad and has been active in community and theological affairs.

More from the mail

In a cordial personal note from their retirement home at 14 Ash St., Garden City, N.Y. 11530, Vina and **Ray D. Cooper** tell of joining their daughter and her husband on trips to New Hampshire and Bermuda and then a visit to their former Chicago home area. Ray has fully recovered from hospitalization last year and has achieved good vision since removal of a cataract and the adoption of contact lenses. . . . Anne and **Wallace T. Adams,** 2606 Fleming Rd., Middletown, Ohio 45042, have planned an extensive August trip to areas they did not see on a previous Alaskan trip, including a flight north of the Arctic Circle to the Eskimo Village of Kotzbue and across the date line to Nome. Wally is a trustee of the Engineers' Foundation of Ohio which dedicated its new building in Columbus, and a member of the "Order of the Ring" of the Ohio Society of Professional Engineers. He received 50-year recognition as a Master Mason from Mt. Carmel Lodge, Lynn, Mass., through his Middletown lodge and was awarded the 35-year veteran certificate of the Boy Scouts of America, which also gave him the Silver Beaver Award a number of years ago. Following attendance at our 50th Reunion, Anne and Wally will go to the wedding of a granddaughter at the end of June.

G. Whittier Spaulding, 3402 Highland St., Allentown, Pa. 18104, retired vice president, Pennsylvania Power and Light Co., notes that he and Beth spend summers at their Maine home, Sprucewold, Boothbay Harbor, 04538. With kind and much appreciated praise for Class News, he adds an invitation to drop in and share the delightful view of the harbor. . . . Personal letters from Mary and **Laurence O. Buckner,** 2630 Durham Rd., York, Pa. 17402, include Buck's comments: "I slipped on the ice, shattered my glasses and got a beautiful 'shiner.' Had Mary take a picture and will use it on our next Christmas card." What a way to follow Buck's gorgeous 1970 Christmas card eclipse photo of the sun with a "black eye!" . . . With sincere regret we have heard from Mary Louise and **Richmond S. Clark,** P.O. Box 1400, LaPorte, Texas 77571, that doctor's orders prevented their reunion attendance. Rich was told to avoid the long trip's tension and excitement and not to stray from his low sodium diet. He has specially asked to be remembered to his many friends in the Class.

Post-reunion reflections

Passing a major Class milestone doesn't necessitate any reduction in the warm friendships or slowing of the fast social pace established by our Class and exhibited so thoroughly by the vital group

Mr. and Mrs. Yoshinori Chatani, '22.

of men and women who celebrated our 50th in Cambridge. Although the volume of these notes has been reduced to the maximum set for all Class Secretaries under retrenchment rules, we hope you will increase and not reduce welcome letters to us. Extra copies of the Class Directory are available on request as the supply lasts. We urge you to aid our news efforts by returning the questionnaire attached to the back of that directory, if you have not already sent it in with your photograph. We still need and greatly appreciate your help!—**Carole A. Clarke,** Secretary, 608 Union Lane, Brielle, N.J. 08730; **Edwin T. Steffian,** Assistant Secretary, Steffian, Steffian and Bradley, Inc., 19 Temple Place, Boston, Mass. 02111; **Sumner Hayward,** Assistant Secretary, 224 Richards Rd., Ridgewood, N.J. 07450

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Your secretary, in his constant quest for news, phoned Parke Appel with the usual fine response. This is good in two ways, the Buffalo weather is sunny and dry compared to the Boston area, which is cold and wet, and his report of a card from the **Dale Spoors** in Acapulco, a stop-over on their around-the-world cruise. After going through the Panama Canal, the Spoors are due back in New York near the end of April and will fly from there to St. Louis and return before going back to Richmond.

Madeline and **Parke Appel** changed their spring plans. Instead of going to Mexico City they took a southern U.S. cruise via automobile. They went down the Maryland Peninsula route to revisit Virginia Beach with its memories of Fort Monroe and the S.A.T.C. days of World War I. They enjoyed marvelous sea food in Charleston, and then travelled to St. Augustine where they stayed for a few days without noticeable results-at the Fountain of Youth. At Juno Beach they visited Ruth and Bob Bradley '20 then drove to the Delray Beach Playhouse to see Carlys and **Frank Kurtz** appear waltzing in *My Fair Lady,* reminiscent of the Tech show ballet. They called on Helen and Edward Walcott Booth '21 and Mrs. Donald B. Lovis '21. Key Largo was their next port of call, where they stayed a week. While in Key West they rode the Conch Train and visited the homes of the Presidents. From this far southern point they drove back to Miami and across the Tamiami Trail to Naples and Venice where they may relocate in another year. After seeing the sights in Sarasota and St. Petersburg, they drove to Atlanta. Charlottesville and Monticello were the next stops and then north to complete their 24-day, 4,635-mile tour in good weather and good health. On April 10 Boston was again covered with snow which made them regret not stopping in sunny old Buffalo for a warm, pleasant Easter. Parke talked to **William E. Huger** in Atlanta who asked to be remembered to all. He also received a letter from **Don Carpenter** who just returned from a two month trip to Africa.

All members of our class are invited to stop on the eastern shore of Maryland to call on **Charles H. Whittum.** He is located not far from the Bay Bridge going to Annapolis in a still unspoiled area with good fishing and excellent boating and sailing. . . . **Earl T. Heitschmidt,** Chairman of the Board of his architectural and engineering firm has retired from active practice. Added to his many previous honors is the Citation of Appreciation from Loma Linda University. He was elected to membership in the Founding Friends of Harvey Mudd College and Member Emeritus of the American Institute of Architects. . . . **Oscar Horovitz,** who has completed his golf assignment of four months at Pompano Beach, Fla., will spend the summer around Boston. . . . **Yoshinori Chatani** of Tokyo, Japan received the Fourth Order of Merit with the Medal of Sacred Treasure given by the Emperor of Japan for service to the steel industry and the foreign trade of Japan. He and his wife were invited to the new palace and both were received in audience by the Emperor. The picture appearing above shows them wearing the medals. . . . **Charles W. Maschal** of Laguna Hills, Calif., has been "active enough to make the leisure in Leisure World a misnomer." He is somewhat restricted by two detached retina operations but enjoys a most constructive life. . . . **Bernard M. Rivkin** has retired from the engineering firm of Metcalf and Eddy and Stone and Webster in Boston. . . . **Herman P. Plaza,** Course VI of Valparaiso, Chile has retired from all activities. . . . **Chang Tse Chien** of Tapei, Taiwan is still Chairman of Mobil China Allied Chemical Industries, Ltd. Since the sale of American interests in M.C.A.C. to the Chinese government, the firm has become a government enterprise.

The 1970 L. F. Hickernell Award has been made to Roger Chang '69 for his prize winning paper "Reliable Analysis Programs for Electric Power Distribution Systems". **Lattimer F. Hickernell** is remembered as one of the outstanding students in our class and for his technical work and publications on conductor materials and electric cables. The Award was established in 1966 by Anaconda Wire and Cable Co. . . . We are sorry we cannot report on the Mexico City Fiesta in March as your secretary arrived there from Yucatan on the day after it ended. Our Buffalo Trade Mission to Central America was successfully completed by resting the last three days at the Hilton in Acapulco. We especially enjoyed the week in Guatemala at Antigua and later at Ponjachel on Lake Atitlan and Chichicastenango.

We send our sympathy to the family of **Charles Adamson Chase** of Castine, Maine. He had been living in retirement since leaving the Bell Systems Laboratories in Chester, N.J. He was a naval architect and marine engineer who helped develop the sonar system of World War II and worked on designs for undersea cables. . . . We note with regret the death of **John F. Ryan** of Pelham, N.Y., a patent attorney and formerly active in the local Republican party as Town Councilman. He is survived by his widow, the former Loretta Bergen; a son, William; a daughter, Mrs. William McNulty, and a grandson.

The changes of address listed are: Myron K. Lingle, Springfield, Mass., Thomas D. Tyne, New Shrewsbury, N.J., Dr. Charles G. Moore, Green Valley, Ariz., Frank H. Wood, The Wood and Spencer Co., Cleveland, Ohio, George B. Allen, Olympia, Wash.; E. Irving Bell, Hollywood, Fla.; William J. Edmonds, Bainbridge Island, Wash.; Luciano A. Preloran, Buenos Aires, Argentina.

Our best wishes are extended to Brenda Kelley on her new assignment. We know she will do an outstanding job, as will Kathy Sayre, who is now the Alumni News Editor.

Now hear this: If you are not at Alumni Homecoming June 6 and 7, we will certainly expect to hear from you during the year and see you at our 50th reunion in 1972. Come and have fun!—**Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y.; **Oscar Horovitz,** Assistant Secretary, 45 Gerard St., Boston, Mass. 02119

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Top priority in the 1923 Class Notes goes to a letter written by our Class President, **George A. Johnson** to our very busy Secretary and Treasurer, **Thomas E. Rounds,** which is quoted in part as follows: "My dear Classmates: Thank you for your confidence in honoring me by electing me President of the Class for the remainder of **Howard Russell**'s term as Class President. I am sorry that he found it necessary to resign. I hope that you will all give serious thought toward planning to attend our 50th reunion in 1973. We have already begun to plan various functions, and we will keep you fully advised of our progress and arrangements as the date for that gala event approaches. Sincerely yours, George A. Johnson." George aptly expresses the feelings of the Class when he praises Tom for all he has done concerning the conduct of the recent class elections during a period when Howard was so far away and when George has been ill for such a long time.

Colonel **Walter E. Richards** wrote that he has been a patient in the Letterman General Hospital, San Francisco, Calif., for several weeks, but was recently discharged. The diagnosis was "exhaustion" and of course the admonition was to "take it easy." He is a member of the U.S.A.F., retired. Colonel Richards states that he and **Howard Russell** are both Founder Members of the Order of Daedalians and are planning to attend the annual meeting of this order at the Maxwell Air Force Base, Alabama, which may take place by the time you read this.

In a delightful letter I received from **Milton E. Parker,** he refers to "our halcyonic undergraduate days at Cambridge." Mep continues his interest in food processing industries, but admits that this is subordinate to his continuing interest in education trials and tribulations, "particularly those concerned with engineering and technology." Mep says that he was spurred on by **Phil Coleman** "who is often referred to as Mister M.I.T. of Chicago—most deservedly so" to review the Report of the Commission on M.I.T. Education, and sent a letter to Mr. Karl R. Van Tassel, president of the M.I.T. Club of Chicago on the subject. It is apparent that Mep believes that both the student body and the Alumni should be involved in plotting the future course of education at M.I.T. . . . I am forwarding the letters from Colonel Richards and Mep Parker to **Dave Davenport** for his review in connection with our Class History. Incidentally, Dave wants to hear from all you "latecomers" and he will be discussing the next phase of the History with **Tommy Rounds,** who is enjoying a few days of relaxation in balmy Southern climes.

It is with regret that we record the passing of **John L. Brill** in New Castle County, Delaware, on February 8, 1971. He was a retired director of research and development in the du Pont Company's Film Department. He was retired after 38 years with du Pont. He was born in New York City, and attended St. Paul's School in Concord, N.H. He received his master's degree in chemical engineering in 1924. He is survived by his wife, two sons and two daughters. A full account of his successful life story will be included in the forthcoming Class History.

As a result of correspondence concerning recent class balloting, we have uncovered a large number of address changes as follows: Emil S. Birkenwald, 4011 Rosenell Rd. N.E. Apt. F3, Atlanta, Ga. 30342; Herman Bruson, 98 Ansonia Rd., Woodbridge, Conn. 06525; Malcolm L. Carey, 116 Mortlake Ave., St. Lambert, Quebec; Hugh D. Chase, 53 Spear St., Quincy, Mass. 02169; Arthur W. Davenport, P.O. Box 574, Virginia Beach, Va. 23451; John C. O'Flaherty, 3751 So. Gilpin St., Cherry Hills Village, Colo. 80110; Charles Goldstein, 20 Kilby St., Boston, Mass. 02109; Hou Y. Hsu, 2188 W. 32nd Ave., Vancouver 8, B.C.; John V. Janes, 506 Olive St., St. Louis, Mo. 63100; Colonel S. P. Meek, 50 East Rd., Apt. 4H, Delray Beach, Fla. 33444; Louis A. Metz, P.O. Drawer 550, Delray Beach, Fla. 33444; Stephen B. Metcalf, 649 Albemarle Dr., Shreveport, La. 71100; H. C. L. Miller, Shooters Hill, Richmond, Va. 23233; Clarence J. O'Dell, 405 Oleander Ave., River Park, Ft. Pierce, Fla. 33450; Earl C. Palmer, Jasmine Lakes, 123 Oleander Dr., Port Richey, Fla. 33568; Leslie W. Powers, 164 116th Ave., Apt. 4, Treasure Island, Fla. 33206; Lewis J. Powers, 166 Mulberry St., Springfield, Mass. 01105; Colonel Walter Richards, Box 522, Belvedere, Calif. 94920; Roy G. Rincliffe, 1000 Chestnut St., Philadelphia, Pa. 19105; Ralph E. Rubins, 2134 Via Puerta, Laguna Hills, Calif. 92653; F. LaVerne Smith, 11541 Weatherby Rd. Los Alamitos, Calif. 90720; Henry Y. Satterlee, La Crescenta, Calif. 91214; Edmund J. Thimme, 530 Valley Road, Upper Montclair, N.J. 07000; Chaplin Tyler, 2401 Penna. Ave. Apt. 1014, Wilmington, Del. 19806; Lawrence J. Tracy, 17 Shore View Dr., Box 307 East Orleans, Cape Cod, Mass. 02643; Norman L. Weiss, 2620 N. Norris Ave., Tucson, Ariz. 85719; Marion E. Warner, 1 Farnsworth St., New London, Conn. 06320; William Webster, 4390 Prudential Tower Bldg. Boston, Mass. 02199; J. Curtis Willson, 1057 Stratford Lane, Bloomfield Hills, Mich. 48013; William P. Winsor, 80 Park Ave., N.Y.C. 10016; Ralph E. Rubins, 2134-0 Via Prierta, Laguna Hills, Calif. 92653; Dewitt W. Bennett, 740 Halsted Rd., Rockford, Ill. 61103; Lawrence E. Lovejoy, 23 Pratt St., Melrose, Mass. 02176; R. Kirk Askew, Jr. Durlacker Brothers, 538 Madison Ave., New York, N.Y. 10022.—**James A. Pennypacker,** Assistant Class Secretary, Long Hill Road, Essex, Conn. 06426

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A logical approach to most problems is to begin with number one. So we begin with Course I—**Sam Shulits,** Visiting Professor of Hydraulic Engineering, University of New Brunswick, Fredericton, N.B., Canada, was Penn State's loss, Canada's gain in 1968, as Sam joined us sexagenarians, rated as a fluvial morphologist. His research project, "Bedload Formulas" (no connection with mattresses) was so much in demand that it has been reissued and Sam is translating it into German. Not difficult for him with his European experience. Son, Walter, is doing very well in his third year at West Point. Daughter, Erica (13), is the sunshine around home. Long time since our 1922 stream-gauging days at East Machias, Me. . . . **Frank Manley,** Course I, and Kitty, now basking in the sun, Sarasota, Fla., have forsaken Fitchburg, Mass. They had returned from a trip to the Caribbean Islands when **Paul Cardinal** contacted them in March and got togegether for a day at Paul's apartment in Siesta Key.

Ray Lehrer, our esteemed Treasurer (Balance on Hand) and Dorothy left their West Newton Iceienda in February for Arizona, hoping to return with color and energy to tide them over to a similar climate in New England. He sends a colored picture card of a Desert Road Runner who "would rather run than fly." That is not Ray's philosophy.

Luis Ferré, Course II, Governor of Puerto Rico, is the subject of an article by M.I.T.'s Dr. Chandler Harrison Stevens in *New Scientist and Science Journal* of February 11, 1971. Luis is making a determined effort, from his technical background, to apply science in government, but tempering it upon advice from ordinary citizens. His plan consists of five innovations. First, an advisory council formed of outside scientists, Puerto Rican scientists and private citizens. They are not searching for problems to solve, but rather the science that can be used. Second, an institute of social technology dedicated to applying the system approach to social problems. Third, a computer center, called a scientific systems center, has been established. This will be available to a variety of government agencies which will cross-communicate, consolidate and share data-banks. Four, a small theater beneath the governor's office is a locus called P.R.I.D.E.—Puerto Rican Information and Decision Environment. Here,

Governor Luis Ferré, '24, (left) shown here with highway director Raymond Watson, S.M. '59, was featured recently in Engineering News-Record; *the article outlined the latest work of the Puerto Rico Ports Authority in expanding Puerto Rico's highway systems and projecting for future transportation needs of the commonwealth. (Photo: Courtesy of* Engineering News-Record, *November 5, 1970)*

audio-visual, information retrieval and graphic display equipment provide decision-making material. Five, a citizen feed-back system should be completed shortly. "Citizen aides" located around San Juan, and mobile units travelling in suburban areas gather opinions and suggestions, increasing confidence in government by ordinary people. Luis is really dedicated to improvement of his Commonwealth. More power to him!

None other than **Dr. Philip K. Bates,** Course VII, food technologist extraordinaire, during the earthquake got a free rugged bedshaking for a minute. (Costs 25¢ in a motel.) A few new cracks in ceilings, but no real damage. Phil has been in Guatemala again and able to sleep during the 1:00 to 5:00 a.m. curfew when shooting and street noise has stopped. . . . **Edward F. Britt,** Course X, writes on an Alumni Fund envelope, "I love the puzzles in the *Tech Review* even though 90 per cent are too difficult." Ed's career is about as puzzling to us. He lives in Jenkintown, Pa. and at one time had a business partner in Philadelphia, but is now retired. . . . **Paul Cardinal** Course XV, got ideas in Florida. Came up with 50th reunion possible sites as Puerto Rico, Spain, Portugal and Bermuda. Would be exciting, but I believe that many members, and especially the Gift Committee, prefer funneling the green stuff into the Environmental Laboratory Fund. We salute those who can do both! . . . **Si Duevel,** in Florida, on his 70th birthday was hosted by classmates, climaxed by a presentation of a giant tiger shark's jaw at the Mote Marine Laboratory for which he had designed hydraulic tanks and equipment, while not fishing. Rumors have it that the tanks are shaped like thermos bottles.

Finally, Grads—Lieutenant General U.S.A.F. (retired) **James H. Doolittle,** known internationally as "Jimmy," received his master's degree with our Class. The United Aircraft Corporation's January 1971 issue of *Bee-Hive* featured him in an article "From Jenny to Superjet." Jimmy studied mining engineering at the University of California hoping to see the world and build things. He switched from mole to bird by joining the Air Service in 1917, beginning one of the most remarkable careers in United States aviation history. At 74, he has flown, engineered and consulted on everything from JN4's to Boeing 747's. Jimmy's two big contributions to aviation knowledge were (1) determination of loads to which aircraft are subjected in flight and (2) instrumentation for blind flying. Crashes he has had, but survival had been planned and practiced again and again, for years, sometimes. His philosophy is erudite and simple. "We are on this earth to serve our fellow man. Almost every individual I know who retires to complete inactivity and is able to serve, but does not, either dies or becomes a cranky old man. The former I'd like to defer as long as possible and the latter I'd like to avoid entirely." Wouldn't we all?

We regret to report that **Stanley T. Cook** lost his wife some months ago. Our sympathy to Stan and his family. Stan is a New Englander who switched years ago to Grand Rapids, the Clipper Belt Lacer Co., according to our records. He was captain and hottest player on the M.I.T. 1924 basketball team, being the only one wearing a heavy pull-over sweater in the *Technique* picture.

The Alumni Advisory Council held its last meeting before reconvening October 25. **Ed Moll, Herb Stewart, Ray Lehrer** and your Secretary heard Professor Baddour CH'49 talk about the new "M.I.T. Environmental Laboratory." Last Fall, Professor Baddour was appointed its first director by President Johnson. You all know by now that **Jack Hennessy**'s 50th Year Gift Committee has as its goal financial aid for this laboratory. One can envisage the very necessary coordination in such a colossal problem as environmental control which involves expert scientific knowledge in civil, electrical, mechanical, aeronautical, biological and chemical fields. President Johnson, personally, told your scribe that he and the Corporation were well aware of and appreciative of the timely 1924 program now under way. Incidentally, all alumni are invited to attend an Alumni Advisory Council meeting, the fourth Monday each month beginning next October. The sociability offers an excellent opportunity to get a cross-section of alumni thinking.—**Russell W. Ambach,** Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

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I believe I noted earlier that **Ed Kussmaul** was retiring gradually. Perhaps he has reached the final stages since he, along with Charles E. Burt, the former treasurer of the Kelek Co., was honored at a company dinner. About 170 people from the electrical industry attended the ceremonies at the Club Car in Norwood, Mass. . . . A telephone call was received from **Ted Mitcham** of Middlebury, Vt., when he was in Boston. He said he would write more information on his doings later. . . . The following is from a letter by **Hank Hoar.** "I'll sketch what major points have been in my life since leaving M.I.T. Went to work for U.S. Steel and spent 37 years with them, retiring at end of '65 as assistant manager of sales in Pittsburgh. Was married in 1930 in Richmond, Va., to a beautiful gal who is still a wonderful partner. We had three children, a son and two daughters. We retired to Williamsburg, Va., as it is a fascinating place and a college town, and we both love Virginia. I have a most wonderful time as a volunteer at the college library, a fine new one. I help on my own time in the rare books and manuscript section, putting five to six hours there daily. They seem to think it helps, and I sure love it. The house we bought is only a ten-minute walk from the library. Maria, my wife, keeps busy with her garden club, work at the Day Care Center, etc. That's all about us. If by chance any of you visit Williamsburg please look us up. That's another nice thing about this place—it gives us a chance to see old friends."

I have already noted the passing of **Nelson DeFoe.** However I am glad to include the following which was prepared by Sam Spiker. Nelson Henline DeFoe died suddenly on December 5, 1970 at the age of 72 at his home near Christiansted, St. Croix, U.S. Virgin Islands. When Tod came to M.I.T. as a freshman in the fall of 1921 he had substantially recovered from serious battle wounds sustained in France near the end of World War I. Although he was several years older than most of us in the

class, more mature and serious, he was also as fun-loving and playful as the best of us. He was very active in numerous undergraduate affairs including Combined Musical Clubs management, Baton, Beaver Club and Osiris. After leaving M.I.T. he learned to fly in the Army Flying School and spent much of the next 20 years in various fields of aeronautics. However, in the early thirties he had a most successful detour inducing many great but hard pressed companies to have major exhibits at the 1933 Century of Progress in Chicago, a World's Fair which turned out to be a bright gem in a troubled world. In the late twenties he was with Fairchild Aerial Survey Co. and also with Anthony Fokker, that almost lengendary Dutch aircraft designer and builder. Before and during World War II his broad familiarity with the aircraft industry and those in it made it possible for him to find sources of supply for many vital parts needed by military aircraft manufacturers. He did an outstanding job in this area for years.

After the war he was active for about 15 years in several public and private activities and lived in many faraway places such as Mexico City, the Philippines, Majorca, Italy and Switzerland. He probably got the most satisfaction during this period from a government job he did for about two years in the Philippines as the chief advisor to an American group in the Industrial Development Center charged with the establishment of new industries and the expansion of existing ones. In the early 60's he moved to St. Croix and became an active registered real estate agent. They built a modern house on a hill with a breathtaking view of the sea. Tod is survived by his wife Helen Earle DeFoe, six children, 13 grandchildren, and also by his mother who is active and in good health.—**E. Willard** (Will) **Gardiner,** Secretary, 53 Foster St., Cambridge, Mass. 02138

26

This issue of notes comes once in five years. Written a month *before* reunion, you will read it *after* reunion. Hence we must make it some kind of special issue. Last Sunday we brought the Class Notes folder over to our tiny guest house and organized it so that today one week later we can pick out clippings and sit at a table overlooking the sea in a relaxed contemplative mood (it's that kind of sea today) and dedicate this issue to our classmates who have not retired. There are many and we will cover only a few, starting with one of the most active: "**Chester F. Buckley** was elected board chairman of American Gage and Machine Co., a Division of Katy Industries, Inc. Mr. Buckley joined A.G.M. in 1957, when he became president of the Standard Transformer Division of A.G.M. in Warren, Ohio. He was named vice president of A.G.M. in 1958 and president in 1962. Buckley is also president of International Metals and Machines, Inc. and Middle South Industries. He is also a director of Katy Industries, Inc., Ludlow Typograph Co., British LaBour Pump Co. of Wellingborough, England, and Ludlow Limited of Raynes Park, England." We expect to see Chet at reunion—he never misses.

Another '26 man may have retired from his former activity but from the following you will see that he merely retired to new responsibilities: "**George P. Edmonds,** honorary chairman of the board and former president of Wilmington Trust Co., was elected to the board of directors of Christiana Securities Co. at the annual shareholders meeting yesterday at the Hotel du Pont. He succeeds the late Henry B. du Pont who died of a heart attack April 13. Edmonds, in addition to his association with Wilmington Trust Co., is a director and member of the finance committee of the du Pont Co. . . . **Walter Lobo** has found a way of continuing his business by moving from New York City to New Canaan, Conn. and tells us: "I note that so many of my classmates are retiring, or have retired. But that is not for me just yet. I continue my consulting office, alone, but find enough clients to keep me busy for the most part. I do have some colleagues whom I call in to help me occasionally. I have a part-time secretary and she keeps quite busy filing, for, as all engineers, particularly chemical, I am a squirrel for information and data. A business trip to the U.S.S.R. in the next few weeks is in the offing so that life is continuing to be rewarding and interesting as always. The only classmate I ever see, other than **Paul Mahoney,** is **Jay Goldberg,** another consultant, but now that I have moved from New York I doubt I shall have lunch with him as frequently. But I hear **Don Green** is playing lots of golf, and many others are 'loafing.' "

And to prove that professors do not necessarily retire here is a newspaper clipping about "Bob": "Professor **Robert B. Morrissey,** Chairman of the Department of Physics at Manhattanville College, joined the faculty of Sacred Heart University, as Professor of Physics, in September. He received his undergraduate and graduate degrees from M.I.T., where he was a member of the physics faculty for five years. He has also been a member of the physics faculties of Columbia University and the University of the City of New York." . . . Finally from Raleigh, N.C. a back-of-the-envelope note from **Clinton B. Galphin:** "Since 1969 I have been President of L. E. Wooten and Co. I see or hear from several M.I.T. classmates: Chester Buckley and Irving Tourtellot."

We have a classmate in San Antonio who has about ten years on most of us and each year his Christmas card emphasizes that he is still as active in his engineering office as ever—**Martin E. Staley**! . . . From the retirement angle however we have one classmate who at retirement age is reaching the peaks of his entire career. **Dick Pough,** who I recall seeing alone on the Gloucester beaches with his bird glasses as an M.I.T. undergraduate has been an active conservationist all his life. He now holds the presidency of "The Natural Area Council, Inc." and of the "America the Beautiful Fund" and is director, advisor or trustee for twenty-two other organizations, including the National Audubon Society, National Parks Association and the Open Space Institute. As we have said before, it is delightful to bask in the reflected glory of the class of twenty-six. Cheerio until we can tell you about reunion.—**George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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In the February notes, I retired **Joe Melhado** as of the end of 1970. Standard Brands says that he has to work until September 1971 and I guess they know more about it than I do. In the rest of his letter, Joe says: "Have no definite plans after that date. I could probably use a few weeks, at least, of 'dolce far niente'. But I know I shall be getting restless and will have to find something to keep me active, remunerative, if possible, but otherwise voluntary. Meanwhile I'm keeping just as busy at the office as though I were going on and on, getting the lawn in shape, and trying to balance the Westchester Symphony Orchestra's budget."

I've now seen and read **Erik Hofman**'s new book. The full title turns out to be: *The Steam Yachts—An Era of Elegance* and it was published by John de Graff, Tuckahoe, N.Y. It's an extraordinarily well put together volume.

Here is how **Bill Kaplan** wrote of the big event: "I have finally joined the ranks of the unemployed—having reached the magic 65. I expect to get 'consulting' cards printed and maybe I'll make enough to pay for their cost. Specialty will be gasoline (volatility, antiknock, stability, emissions, etc.). I'm still single but maybe I'll meet that widow." Bill's new home is at 1885 Diamond St., Apt. 2-329, San Diego, Calif. He says about the new spot: "The weather is conforming to my expectations, like perpetual spring; the humidity is almost too low. People are friendly and the community is amazingly clean. I am scheduled to give a course in vehicle emission controls at the University of California Extension in July. Although most of us are apprehensive about what we will do when there is no place to report to work, this has been like starting a new exciting life, and I'm enjoying it. My refreshment cabinet is stocked, ready for visitors. So look me up when you get in this area." . . . As he leaves the active management of SuCrest Corporation, **Frank Staples** has been named "Sugar Man of the Year, 1970" at an award luncheon at India House in New York. The citation pointed out that Frank "has consistently contributed technologically and administratively to the growth and welfare of the sugar industry. His determination, skill and energy have been given freely and enthusiastically. He conceived and

A recent gathering produced this snapshot of '27ers: Bob Wallace, Molly and Jim Lyles, Barbara Wallace, Ray and Zella Hibbert.

designed floating cranes to discharge raw sugar from ships and also designed a tepee-shaped silo for storing raw sugar, and pioneered the use of ion-exchange in sugar refining."

On the other hand, **Frank Connally** won't say uncle: "Still active on construction work. Feel like a million dollars. If there are any other people from M.I.T. living in San Clemente, Calif. or environs, I would like to meet them." (I sent Frank the names of four alumni of various classes listed in the register, and would be glad to do the same for others. Couldn't find R. M. Nixon in the San Clemente listing; he must have gone to some other institution.) . . . **Mark Robbins,** our auto race buff, writes "Daytona in the winter, northern U.S. and Canada in the summer, with California for Thanksgiving." . . . You wonder how many car racing fans there are in the class. **Bill Richards,** before he went to raising broccoli, built himself a racer, entered the Indianapolis 500-mile classic. He was well up among the leaders when an accident ended his career as abruptly as it had started.

We greatly enjoyed a recent visit here from **Bob Wallace** and his wife Barbara. Bob retired from White Motor in 1967 but after a taste of retirement, went back to work at Brockway division of Mack Trucks in Cortland, N.Y. Now he is set for a re-retirement and says this may be final. For the near future, the Wallaces will live near a daughter in St. Charles, Ill., west of Chicago; they are definitely planning to make it to the Forty-fifth at Bald Peak. Bob was asked to write a paper for the S.A.E. on "Evaluation of Truck Design." It was delivered both in Washington, D.C. and Syracuse, N.Y. Before the Wallaces hit Mystic, they had stopped by at Canaan, Conn., to visit Molly and **Jim Lyles.** The **Ray Hibberts** were there for the event. Bob reported Jim in "great shape." A snapshot of this happy reunion is shown above.—**Joseph S. Harris,** Secretary, Box 654 Masons Island, Mystic, Conn. 06355

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Last month we mentioned the letters and papers sent in by **Herman Jones.** Herm's business is the Cayuga Pottery Co., Inc. in Ludlowville, N.Y. Having suffered directly from the devastating competition of favored foreign imports, Herm is now waging a one-man campaign for correction of the faults in our foreign trade policy. Herm points out that, as a result of free trade, foreign low-cost labor floods our markets with cheap goods that not only drains away our dwindling gold reserves but is steadily destroying industries and jobs in this country. To correct this evil trend Herm offers what he calls a fair exchange policy (F.E.P.). Under this plan foreign goods would be imported at a price high enough to make such goods just competitive with domestic products. However, this higher price would be paid in scrip or a kind of paper gold usable only for the purchase of American goods. Furthermore, American goods exported would be paid for with a combination of the scrip and a lesser amount of gold. In this way domestic manufacturers would be in a better position to compete with foreign imports, jobs in this country would be protected, foreign manufacturers would receive better prices, and gold would again be brought back into the United States. We hope that this is a correct summary of Herm's F.E.P. philosophy. He would be glad to correspond with anyone who wishes to discuss this or any related matter. He has been thinking and writing on this subject for a number of years and believes that he has a good many of the answers. . . . In the March 1971 issue of *Mechanical Engineering* there appeared a photograph of **Louis J. Kelly** as he received his Fellow certificate in the American Society of Mechanical Engineers. The event took place in September 1970 at a San Francisco Section meeting of the Society. Louis is vice president, Refinery and Chemical Division, Bechtel Corp., where he has been since 1961. Prior to this he was assistant vice president and director of engineering with M. W. Kellogg Company. . . . **Dave Mathoff,** who experienced two such occurrences last year, had another heart attack this spring. He was in the hospital for three weeks. At the time of this writing he had returned home. Although recovering slowly, Dave was beginning to feel better and was looking forward to the warmer weather and better health. . . . **Bob Schuler** sent in this very welcome letter: "I still have pleasant memories of our 40th class reunion and am now sending a few notes to bring up to date those of my classmates whom I know well. Perhaps this letter will arrive in time for the next issue of the *Review.* I am at present a group manager in Research and Development of the Toiletries Division of the Gillette Co. in Boston, and I am still living in Newton. Retirement is about a year away. Dorothy and I expect to take a trip this year to England to visit the family of our elder son, John, who is now in London for the practice of general surgery for one year in King's College Hospital (University of London Medical School). John has just finished three years as an intern and resident with the Harvard Surgical Service in Boston. He received his M.D. degree from the Harvard Medical School in 1967, and his B.A. degree from Dartmouth in 1964. Our younger son, William, is finishing his last year of active service as a first lieutenant in the U.S. Marine CORPS at Camp Pendleton, Calif. He recently returned from one year of combat duty in Vietnam, where he was awarded the Bronze Star with Comat V and the Purple Heart. Upon his discharge from active service in August 1971, he plans to enter graduate school for an M.B.A. He is a graduate of Tabor Academy and Boston University School of Liberal Arts. Otherwise, life continues its placid course towards retirement."

From **Harold Geiger** we have this note: "Retired in 1969 after 34 years as Chicago District Manager, International Nickel Co., Inc. Now spending time on home repairs and some travel. Have had six weeks in Europe and a few two-three week trips in this country. Currently I am working on oil paintings of steel mill scenes for my son's office. He is also a metallurgist." . . . **Bud Gray** appeared in several recent news items. In the March issue of *Focus* (The Conference Board, Inc., N.Y.) we read "Elisha Gray 2nd, Chairman of Whirlpool Corporation, calls on business to take a firm and participatory hand in the consumer education field. He describes the educational system as 'a major and virtually unused resource for the consumer.' Mr. Gray says the ultimate goal is to make consumer courses a permanent part of formal education." A second item is from the Worcester (Mass.) *Telegram* of March 21, 1971.

Bud, who is national chairman of the Council of Better Business Bureaus, addressed a meeting of the Worcester bureau on March 20. He urged expansion of the Bureaus' activities to meet the growing pressures of consumer sensitivity. Strengthening the Better Business Bureaus he regards as the practical alternative to government regulation.

The *Georgia Tech Alumnus* for February 1971 carried a very good four-page story on **Robert S. Woodbury,** professor in the Social Science Department at Georgia Tech. Bob left the M.I.T. faculty in 1969 to become Callaway Professor of the History of Technology at Georgia Tech. The assignment was to have been for one year. By that time Bob had become so attached to the place that he readily agreed to stay when the invitation was extended to him. His teaching subjects relate in large degree to the history and to the social implications of various aspects of technology. He has published books and monographs on the history of tools. His 1971 lecture series will focus on little-known but important contributions to various fields of technology. Bob appears to live a very full and busy life with interests that range from flying (he was a Navy pilot) to Chinese cooking. He has received outstanding professional honors and has lectured in Poland, the Soviet Union, and in Spain. Best of all, it is obvious that he thoroughly enjoys the life he leads.

We were much pleased to receive the following note from **Monte Burgess** which arrived just in time to be included in this issue: "Starting in 1971 will begin my seventh year of retirement and the same for self-employment. I am very busy with private investment management problems. Results are very gratifying. Blanche and I organized a combined popular and classical music group. We have three requirements—interest, dependability, and a good musician. We meet in our home every three months and gave a program for our church in February. We had rave comments on the latter and expect to repeat next year. Blanche plays piano and organ; I play trumpet, piano and drums. We have made seven motor trips to Mexico, including Guatemala and San Salvador, in the last ten years. I have taught myself Spanish and enjoy talking to the natives. We are in the best of health and enjoy every minute by keeping busy."—**Walter J. Smith,** Secretary, 209 Waverly St., Arlington, Mass. 02174

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I deeply regret to inform you that **Lee J. Schnackenberg,** Course XV, of Wakefield, Mass., passed away on March 8, 1971. No details are available at this time.

Three Twenty-Niners had a mini-reunion in South Florida last April. Sally and **Bill Bowie** and your secretary and his wife Helen spent a delightful afternoon with Helen and **Hugh Hamilton** at their winter home in Boca Raton, followed by a luncheon at the yacht club. We had such an enjoyable time that our hostess is planning a similar get-together with perhaps a larger group next winter, around February, March or April. For those of you who are planning a trip to Florida during that period, if you send me a card and tell me about your plans, you may get an invitation. Since Frank Mead also has a plan in mind for a winter reunion, there will be more on this subject in later issues of the *Review.*

Charles M. Perkins, Course VI-A, of Ipswich, Mass., presently a consultant to the Fuller Transmission Division of Eaton and Yale, Inc. of Kalamazoo, Mich., had the honor of presenting the L. Ray Buckendale Lecture at the 1971 S.A.E. Automobile Engineering Congress and Exposition on January 11. In his lecture "Principles and Design of Mechanical Truck Transmissions", Mr. Perkins analyzed characteristics of mechanical truck transmissions required for maximum performance and economy and showed various constructions for achieving the results. He also presented methods of determining life of components and of rating transmissions for a variety of applications and discussed devices to minimize the skill required for shifting. Mr. Perkins has been associated with Fuller Transmission Division in various capacities since 1948. He served as Fuller's chief engineer from 1958 to 1967, when he became a consultant to Fuller.

Herman P. Meissner, Course X-A, of Winchester, Mass., a leading authority on industrial chemistry, has been appointed Lammot du Pont Professor of Chemical Engineering at M.I.T. Professor Meissner was appointed assistant professor in the Department of Chemical Engineering in 1940, became associate professor in 1943 and professor in 1951. He was previously a du Pont fellow in business administration from 1932 to 1933 at M.I.T., instructor in business and engineering administration at the Institute from 1934 to 1936, and an M.I.T. instructor in chemical engineering from 1938 to 1940. Professor Meissner received his Sc.D. degree in 1938 from the University of Frankfurt am Main, Germany, after taking his S.B. and S.M. degrees from M.I.T. in 1929 and 1930 respectively. He has just completed a significant book in the field of industrial chemistry, *Processes and Systems in Chemical Engineering,* just published. He is the author and co-author of numerous other books and publications.

Marshall S. David, Course II, of Wellesley Hills, Mass., has sent the following informative letter to Frank Mead in respone to the Homecoming activities: "Thanks for advance information on the plans for Pops this year. We will have to take a rain check as our social life this year is somewhat uncertain. I was retired on January 1 from Boston Gas, after having served them in many managerial assignments, the last being director of area development. Anticipating this day, we purchased our retirement home at 70 Garfield Lane, Wrinkle Point, West Dennis, Mass. We have been spending a good deal of our spare time there furnishing it, etc. We are only a stone's throw from the Wrinkle Point Beach Club and Marina of which Dorothy is Secretary. Our next-door neighbor is a retired army colonel who keeps an eagle eye on our place and we have a great time exchanging some of our WW II experiences. Incidentally, I have been retired from the army reserve five years after serving 31 years, five years of which was in WW II.

"Prior to retirement, I was active in the American Industrial Development Council, Northeastern Industrial Development Association, Massachusetts Industrial

Development Council, Society of Industrial Realtors, Society of American Military Engineers and New England Gas Association. We are in the process of selling our house in Wellesley and gradually moving our things to West Dennis. Consequently, we cannot make any definite plans. We usually hear from **Cliff Kittredge** at Christmas. He seems to be still busy at Princeton. Sincerely, Marshall S. David."

Hope to see some of you at the Homecoming. Until then—**Karnig S. Dinjian,** Secretary, 32 Oldham Rd., Arlington, Mass. 02174

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Once again the returns are rather lean this month and consequently the notes will necessarily be brief. . . . **John M.** "Marsh" **Cleary** is construction engineer at Anheuser-Busch, Inc. in St. Louis in charge of plant expansions and the like, but is planning to retire as of July 30 this year. The Clearys have five daughters and "10.3" grandchildren. As a diversion and hobby Marsh maintains a paddle-wheeler on the Mississippi, which sounds like fun. He reports that he hasn't seen any classmates in recent years but corresponds with **Reg Bisson** in Laconia, N.H. . . . **George Barker** is vice president and director of research of the Van Straaten Chemical Co. in Chicago. He and Ida have two daughters: Ann, who received an M.D. at the Medical College of Pennsylvania and is an ophthamologist; and Joyce, who attended the University of Wisconsin and University of Illinois, ending up with an M.S. and is now in Korea with her husband, Major J. R. Gallagher, who is in the Army Medical Corps.

Since your Secretary leads a mundane life, he rarely has any personal item to report but this month is an exception. Our Bob, who graduated from Lehigh in '66 and has since been working for Xerox Corporation in Rochester, decided last fall that he wanted to return to school for an M.B.A. He applied to a number of schools, including M.I.T. Several weeks ago he called me at the office and announced in a "cloud nine" tone of voice that he had received an offer of admission from the Sloan School. So next September a third member of the Lister family will be entering M.I.T.—**Gordon K. Lister,** Secretary, 530 Fifth Ave., New York, N.Y. 10036

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By now you have all received the program for our 40th Reunion which begins on June 4 with registration and reception at the Bald Peak Colony Club, Melvin Village, N.H. Everything points to a grand reunion and your Class Reunion Committee, chaired by Ralph Davis, is looking forward to seeing you there.

Word from **Al Kaye** tells of his election to the school board of the city of Hammond, Ind. where he now serves as the secretary of the board. . . . Congratulations to **Carrington Mason** upon his election as senior vice president of Houston Natural Gas Corp., Houston, Texas. . . . Speaking of Texas, **Dave Motter** writes that his address is 1603 D Sherry Street, Arlington, Texas 76010. He retired from Esso in August 1968, was divorced in February 1969 and remarried in April 1969. . . . While in Tokyo recently, I had another very enjoyable evening with **John Minami** and his wife, Yoshiko. John reported that he had to visit Moscow in connection with his professional activities and said that unfortunately he would not be able to attend the reunion.

With regret, I report the death of **Paul H. Doleman,** who received his doctorate in 1931.—**Edwin S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn. 06880

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Halsted R. Warrick, who received his S.M. degree in chemical engineering in 1932 writes the following on his retirement, "After over ten years in London, I am retiring from Texaco and returning to the United States. I will have completed 40 years of service with the company or its affiliates in July this year. For the past four years I have been coordinator, Air and Water Conservation (Europe) for Texaco and also chairman of Stichting Concawe which is the International Oil Companies Study group for Air and Water Conservation (Western Europe). This latter organization is headquartered in The Hague and represents over 80 per cent of the petroleum refining capacity in Western Europe." Hal's address will be P.O. Box 1460, Hendersonville, N.C. 28739. . . . **Frank R. Cook** has taken a new position representing the Lymandel Company and its business management and development services in Orange County, Calif. Frank has managed the Science Management Corp., in its business development and counseling activities for the past several years. Prior to that he had been active in the management of new programs in the Power Sources Division of Whittaker Corp., the aircraft products of Honeywell, Inc., and U.S.A.F. Project Officer for Project RAND. Frank will continue to reside at 461 East First St., Tustin, Calif. 92680

Charles O. Perpall writes that he has retired and spends his summers in Idaho fishing and his winters in Mexico on the beach. His new address will be 12941 Second St. #119, Yucaipa, Calif. 92399.

Colonel **Richard L. Morgan** has worked at the Engineer R and D Center, Ft. Belvoir, Va. since retiring from the Army Corps of Engineers. He goes to the West Indies each winter—this year had a winter golfing vacation in Jamaica. He reports three grandchildren added to his family. He lives at 7401 Gatewood Court, Alexandria, Va. 22307—**Elwood W. Schafer,** Secretary, Room 13-2145, M.I.T., Cambridge, Mass. 02139; **James Harper,** Assistant Secretary, 2700 S. Grant St., Arlington, Va. 22202

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Top billing, this time, must go to **Ellis C. Littmann,** Chairman of the 40th Gift Committee, who writes a bit on that subject. It appears that the Fund is running on schedule and the halfway mark ought to be passed, later in the year ($300,000). Real spade work starts soon, sezzee. Ellis has had a little corrective surgery, and is now OK. After the surgery, Ellis spent some weeks in Phoenix, and tried to locate our own (former) Chuck Thumm; no results. **Morris Cohen** is due in St. Louis

to address the regional group of the American Society for Metals, and has a date with Ellis. Daughter Susie is happy at Mount Holyoke, and son Ron is now the father of still another baby (this time a boy), making three grandchildren for Ellis and Roz; no record, pal, but not common. Thanks, Ellis, How about putting the vice presidents to work now? Note: Ellis is also Class vice president. . . . A note from president **Jim Turner** says he was in St. Louis about the time that Ellis was in Phoenix. Glad to hear from you, Jim. Thanks! . . . **Cal Mohr** writes about a subject close to his, and our, heart: the Avery A. Ashdown Fund, a memorial to the late dear Professor of Chemical Engineering. All course V and X men are urged to make a contribution to this worthy fund. I knew the old gentleman, but not until after we were out of school. . . . Not much classmate news this time from Cal; he says that **Walt Swanton** was, at the time, snowbound and couldn't get out of the house. How about it, Walt? Many thanks, Cal.

I dropped by the **Charles Paynes**, (Red to his family) thanking them for the fine Christmas letter, and Marcia batted for Red, and wrote a return, mostly about the Paynes now rather famous Sister Cities program: Rennes, France; Wurzburg, Germany; Caltanissetta, Italy. It appears that Marcia is the one who works at this one. Their group has had awards from the *Readers Digest* Foundation. Thanks a million, Marcia. We are proud of y'all. It warms one's heart to receive cards from classmates who are travelling. What an easy way to be nice and friendly. . . . **Dyer** and Petey **Potter** were on a Caribbean cruise and mailed a card from Caracas, Venezuela, after stopping at Curacao. The card was of the Plaza Diego Ibarra, not named for a classmate, though seems familiar. Thanks, Dyer. I do wish more of you travellers would write us cards. . . . A classmate, familiar to us at reunions, **Art Hungerford** dropped in to call on us only a few weeks ago. He brought his stepmother with him, and we enjoyed both of them very much indeed. Wife, Helen, apparently had a previous committment in the North and did not even visit Florida with Art. You will recall that Art has been a professor at Penn State, these last ten years, teaching basic broadcasting. Penn State, it seems, operates the year round, four quarters, and it would appear that Art was taking out one of these. Art, we sure enjoyed you; come again. We really go for the reminiscing. . . . We have a nice card from **Beau Whitton,** also a class vice president. Beau and Daphne were leaving for Natchez on the "Pilgrimage of Homes," and while there, Beau intended to check up on his Mississippi office at Jackson. Who sez this Beau ain't smart? Thanks, Beau. You is a nice fella.

Earlier, we mentioned a nephew of **Horace MacKechnie** as interested in *Foxfire,* with no real explanation. Prue now writes as follows: "*Foxfire,* started by said nephew, is a literary magazine dedicated to preserving the folklore of the Southern Appalachians." It is an endeavor to collect from the living folklore which might well pass away with them were it not recorded. The magazine is headquartered in Rabun, Ga., at a school where the students do all the work of assembling material, writing it up, making the photos, and designing. Apparently, the said nephew supervises only, though it all was his idea in the first place. The effort is supported by the Smithsonian Institution, with grants by the National Geographic, the Southern Highlands Society, and others. Subscriptions for this quarterly publication are $5 annually. Anyone interested? If so, drop *Foxfire* a line, with the $5 to Rabun, Ga. Thanks for the further info, Prue and Mac. The story is interesting. . . . From **Emerson** (Emmy) **Norris** comes a nice note thanking me for a card sent him while at the Mexico City M.I.T. Club Fiesta in March. Emmy sent a clipping from a New Hampshire paper telling about our house being robbed. Not so! It was entered, but the culprits vamoosed when an alarm went off and alerted the farm foreman who called the police. 'Nuff said about that. Emmy is definitely interested in next year's Fiesta. It is apparent that my stuff does get read, here and there. Thanks for the letter, Emmy. Maybe your interest will rub off on a few more of us. For me, that Fiesta is marvelous.

We are proud to announce an award to one of our better men: **Norman Levinson,** Head of the M.I.T. Department of Mathematics. This award is called the "Chauvenet Award," and may also be called a prize. Norm made it through a published paper "A Motivated Account of an Elementary Proof of the Prime Number Theorem." This award which carries with it a fine certificate and a $500 monetary tribute, has been used 19 times since its first appearance in 1925 by the M.A.A. Please recall that Norm received his first two degrees in electrical engineering, then after studying mathematics intensively under our old friend, Professor Norbert Wiener, was given an M.I.T. travelling fellowship to spend a year of study at Cambridge University, England. M.I.T. then awarded him his Sc.D. in 1935; hence, a good man can take his doctorate in two years after his bachelors. I do believe that one might well drop Norm a line with personal congratulations. In doing so it makes two people a little happier. Norm, to you our most sincere best wishes and congratulations. In reply (to me) Norm, my limited library can't tell me where the title word, "Chauvenet" comes from; will you?

From **Russell Eddy** I get another, and within weeks of the first. It seems that Russ had made a visit to an ailing company in Connecticut, and on the way home stopped in Waterbury to call on his frater, **Charles** (Chuck) **Fulkerson.** Did he unearth something! Chuck has sold his old company, Waterbury Pressed Metal, and after a time purchased a small outfit manufacturing drawn metal burial vaults. Russ, in retrospect, recalls that Chuck used to be a trustee of the Waterbury Hospital, but is careful not to establish a connection with that and the new business. Russ, you did what I have been promoting for years—dig up classmate stuff on these trips. I do it myself and urge others to "go thou and do likewise." We appreciate your thoughtfulness.

From another of our girl contingent, we have an Alumni Fund Capsule: **Muriel Bliss Wilbur,** sends brief but welcome word that she is Coordinator, Nursing Home Program, Health Education, Babson College, Brookline and is also connected with the Brookline Health Department. Further, Muriel has recently been honored by election as a Fellow in the Gerontological Society; well, you could look it up! I did. Thanks, Muriel, and do not take so long with the next one.

From one of my favorite boys, **Charlie Bell,** comes a fine letter, interwoven with some sad news. Charlie's Helen, beloved of all of us, not to say Charlie himself, passed away on March 7, 1971. Charlie does not give details but avers that it was untimely. Jim Turner also mentioned in his note that there was a memorial service for Helen a day or so afterwards. Those of us who knew Helen, and there were many, offer all we can to as nice a fellow as ever came down the pike, in his days of sorrow. It is a little difficult to imagine why this kind of thing has to happen to one of the great chaps. Charlie, please accept our kindest wishes. Charlie is still a multi-purpose man, what with his very large mobile home site in Hialeah, Fla.; his Industrial Center in New Jersey, started by his father; and miscellaneous designing of specialty machinery and gadgets, in Rhode Island. It was indeed fortunate that the Bells took a prolonged trip last fall to the British Isles, spending a lot of time touring the Cornish Coast, and a week in London at the theaters, museums, and night clubs. A week in London is far too little as some of us have discovered. (I put in four days one time in the British and Tate museums, doing a little research job for an artist friend.) The family: daughter Nancy with her three children and hubby, lives in California, where hubby is with Xerox; daughter Susan lives in North Carolina, with her two children and hubby, who is with the U.S. Public Health Service—both of them are amassing further education; son David expects to receive his M.D. from Boston University come June; fourth and last, daughter Emily, 15, is at the MacDuffie School in Springfield, Mass., and is doing well both with education and the boys. Haw! Oh, yes, mustn't forget the German shepherd, Heidi, Charlie's constant loving companion.

Raymond (Ray) **Brown,** the fella now living in France, is getting ready to manufacture a portable Singer sewing machine for world trade, probably due in the U.S. next summer; making small motors, and head and shoulders in the plastics molding business, all Singer, I expect. Ray and Jo have found a fine, long golf course, 7,000 meters, hilly and mountain-goat-type. After six months in France Ray likes it all real well, but Jo avers that it is not the U.S. Well, maybe not, but even though the Paris winters are rather miserable, Ray, right now in mid-April, you'll eat them words, as Paris in the spring can be delightful. That, I know! Many, many thanks to you both for the long letter, which as one may see, has been forshortened. . . . We have a press release from S.E.S. Corp. (**Dick Morse**'s steam engine research project) which makes the announcement of the prototype steam engine, the first of the kind developed in many years. The release goes on to discuss the internal combustion engine versus the external combustion type, demonstrating the advantages of the latter, pollution-wise. Space prevents our pursuing this discussion but we have the release in case anyone is directly interested. To put it mildly, this new engine appears to have a great deal of merit. And we can rely on Dick Morse to keep us further informed. We all wish you luck, Dick.

A short one from **John Wiley** tells us that he has just returned from three weeks skiing in Switzerland, and a subsequent visit to France. . . . **Dayton Clewell** has also done a bit of travelling, having been a member of a six-man team which gave a series of lectures—on industrial research in the U.S. The scene of these lectures was Poland. My, my! Jean went with him, as she always seems to do. Son Don, has recently been appointed Assistant Professor at the University of Michigan Medical-Dental School, and daughter Nancy is married to a young man who works for C.B.S. No mention of any children through either. Thanks a whole lot, Dayt.

We are saddened to hear of the passing of one of our dedicated researchers, **Morris Green,** who was a biochemist active in cancer research. Morris took his master's at Michigan, and his doctor's at Pennsylvania. At the time of his death he was in research for the U.S. Government at Bethesda, Md. We have already written Mrs. Green, sending the sincere condolences of the Class.

We have changes of address from **Ellery Clark** and **Wolfgang Kloenne.** Ellery was one of our Course II, Mechanicals, and Kloenne was a Course XV, MG. These addresses are available under the usual conditions. (Hence I get few requests.) Last, but surely not least is a further reminder about the 40th Gift Fund.—**Warren J. Henderson,** Secretary, Fort Rock Farm, Exeter, N.H. 03837

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I have some biographical notes this month that are pleasant to report on two counts. Firstly, they concern someone who is still hard at work and thus do not have the sombre connotations of some I've had to write lately. Secondly, their subject is one of the group I was close to in school and have been able to see from time to time in years past. All this leads to the fact that in March last, **A. Gardner Fox** celebrated his 35th anniversary with Bell Laboratories in Holmdel, N.J. After staying on at the Institute to obtain his M.S. in 1935, Gardner joined Bell Labs in 1936 where he worked on mobile transmitters and early radar development. For part of the war he was concerned with radar antenna design and then returned to radio research. He took part in the work on Bell's first microwave radio relay system and then went on to millimeter wave research. Since 1953, Gardner has been in charge of a microwave physics group doing research on ferrites, dielectrics, and semiconductors. He is currently head of the Coherent Wave Physics Department and is concerned with the field of lasers, laser stability, mode and frequency control, pulsing, and nonlinear optics. Along the way, he has been granted 52 patents, is a Fellow of I.E.E.E. and is now serving as editor of the I.E.E.E. *Journal of Quantum Electronics.*

Gardner and his wife Ellen have two sons and two daughters. They have lived in Rumson, N.J. for 18 years and for the last 12 of those years he has served on the Rumson-Fair Haven Regional High School Board of Education, currently as vice president. I'm not sure whether those 12 years don't deserve almost as much respect and recognition as does his career with Bell Labs. I don't think I know of any essentially volunteer job that is generally as thankless as that of working on a school board in these days of conflicting demands and pressures.

Some months back these notes carried a letter from **Larry Stein** mentioning that unfortunately he had become one of the victims of our current economic problems. Happily, came recently one of the "change of address" forms from the Alumni Association that shows he is now with Charles T. Main, Inc. in Boston. This is good news, I'm sure to many in the Class, especially to those who were with him in the rowing days.

Several weeks ago I received one of **Frank Milliken**'s reports as Reunion Gift Chairman. While we are doing pretty well from a dollar standpoint, we are lagging badly in terms of numbers contributing. By June 1970, 52 per cent of our Class had contributed to the Alumni Fund, but as of this past February, only 35 per cent had participated. If you are still tossing that mental nickel, how about bringing it down "heads" and getting in touch with your local solicitor?

I am just winding up a month of jury duty here on the Cape and since my cup of news is not exactly filled to overflowing this month, you might be interested in some of my reactions. This session has heard only criminal cases and both of the judges we have had were most impressive. On the other hand, it is incredible to hear the stupid things people do that land them in trouble. I suppose we are lucky here that the cases generally are of such a petty nature. Our worst conditions are certainly a far cry from the ghettos, but taking a hard look at the quality of both the prosecutions and the defenses, it doesn't take much imagination to extrapolate them to the dimensions of a major city and to realize that what we read of the court situations is not exaggerated. There have been a fair number of drug cases but they have all pleaded guilty. The interesting thing here is to see how the judges will use suspended sentences and probation if there is any sign that rehabilitation is possible. This seems to me a major commentary on their opinions of the efficacy of our corrective systems. I would say that if any of you are called, especially for criminal cases, serve if you can. It can be dull at times, but it's an eye-opener.—**Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass., 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C., 20016

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I was delighted to receive **Ed Taubman**'s letter which follows: "I guess that in the 36 years since graduation this is only the second or third letter I've written for the Class Notes. I think I'm still ahead of many who have yet to break the ice. Of course, having attended all of the five-year reunions, I've had continuous contact with at least the old faithful of our group. I only wish they [reunions] could last longer than two days and encompass more of the Class." Ed adds here that he has come across the 1935 Commencement program which he will bring along to the 1975 reunion to be autographed by those in attendance.

It appears Ed has chosen this particular time to write having had lots of spare time the last few weeks due to a bout with infectious hepatitis which has confined him to his bed. He adds, "In the past several days, I've begun to read voraciously, eat a great deal better and wonder anew at the world of spring unfolding outside my window. Thus, even without an M.D. degree, I would assume that I am on the road to recovery.

"Now as to the last 35 years—November 1935 to 1968 I was in the retail auto supply business with my brother and father. We had our ups and downs, as who doesn't, but lived comfortably. The main problem was the awful hours required in this type of activity. I think all three of us heaved one great sigh of relief when we sold our business in early 1968. Moneywise, we sold it very cheaply to conclude the deal—but we came out 'rich' by the peace of mind we have since enjoyed. Furthermore, the commerical property we had slowly been developing over the past 15 years to provide locations for our stores were not part of the deal, and proved to be a firm basis on which to continue the development of commercial warehouse and retail property since 1968. I've finally got to doing something lucrative that needs only 40 hours work during a five-day week (most weeks). After 33 years of a seven-day week, I have a very guilty (but nice) feeling that I am loafing and goofing off.

"To advance this feeling, I bought a houseboat several years ago and have thoroughly enjoyed my last two summers as a skipper on the Chesapeake Bay. In fact, I have a very official document attesting that I have been appointed 'Admiral of the Chesapeake Bay.' It has been signed by Governor Marvin Mandel and bears the Great Seal of Maryland. I would like to think I received this for my nautical ability, but I have a sneaking suspicion that the fact that my brother and the Governor were high school classmates had a more direct influence. If everything goes as planned, I hope to pilot 'her' down the Inland Waterway next October and leave her around Ft. Lauderdale for the winter. As you must realize, by doing this, I will save the $100 it costs to 'winterize' a boat that is not taken south. Need I say more to confirm the adviseability of this voyage!

"All in all, I've had a very good life thus far; I suspect probably better than 99 per cent of the world. I am getting a feeling that I think many men of my age get at this stage of life—I feel as if I owe something to the world which has made all this possible to me. Not just money, which of course I give in a moderate manner, but something of the experience and abilities I have more or less developed over these decades. I'm looking and shall find something, I'm sure." Thank you for writing, Ed. We all wish you well and look forward to seeing you no later than 1975.

A note arrived via the Alumni Fund bringing us up-to-date on **Oliver Hoag** and explaining that Vermont address: "Oliver Hoag was successful in the Pennsauken, N.J. venture and was elected president of Langan Aperture Cards, Inc. Then he proceeded to metamorphose the company which suddenly appeared in Bennington, Vt., under the name of Filmcard Corporation, to manufacture aperture cards. Number one son Thomas, was recently appointed Professor of Photo Journalism at University of Goiana in Brazil. He had served there with the Peace Corps. Number two son David, operates one of Avon's computers in Hollywood, Calif. Number one daughter Nancy, is looking forward to college in the fall and loves skiing in Vermont." Good luck with L.A.C., Inc. We remember the enthusiasm you expressed at reunion a year ago relative to this new opportunity.

Last fall I wrote to Dexter Clough in Bangor suggesting he get in touch with Ambrose Higgins, a Course IV member of our Class and drop me a note about him. Dexter's sad letter follows: "Soon after receiving your note, I saw **Ambrose Higgins** at Rotary and he was quite interested in joining the Class Golf. I never did get to update his activities until recently when he was in the office and I had the opportunity to do so, little knowing then how short a time he would be with us. Ambrose died yesterday after a brief, acute illness. In him we have lost an outstanding classmate, well-liked by all who knew him and prominent in all things that he did—the list of his activities speaking for itself: President of the Bangor Symphony Orchestra; Past President of the Bangor Chamber of Commerce; First Commander Penobscot Bay Power Squadron; active in Boy Scouts, Rotary and Salvation Army; National Committee on Design, American Institute of Architects; National Committee for Historic Restoration; National Committee for Human Resources A.I.A., and he was sponsored for Fellowship in A.I.A. Sorry that this communication is on a sad note, and I hope that our next will be in another vein—Class Golf."

While making plans for our Class Golf, I had an opportunity to catch up with **Art Marquardt** and Bob Anderson. Art is still with Crowfoot Gear in Taunton as product manager. His wife Elna is keeping busy in the winter by tray painting and in summer, golf. All the children are away: Marky is currently in Newburgh, N.Y. on site construction for Combustion Engineering's Power Plant Erection Division. He is getting married in June to the sister of his former roommate at Tufts. Daughter Ann was married last August and lives in Fairport, N.Y., a Rochester suburb. Her married name is Westcott. Younger daughter, Gretchen, is a junior at University

of Arizona—she wanted to go to a "fun school" far from home.

Bob Anderson, in charge of construction and buildings at Filene's, is being kept very busy. He just finished a new warehouse in Somerville and an addition to the downtown Boston store. Plans are in the making for a new store in Chestnut Hill and, most interesting of all, a new downtown store. Filene's obviously has faith in the future of the inner city. Bob and his wife Barbara play indoor tennis when the weather isn't right for golf. His youngest child and only son Eric returns next year to graduate from Wellesley High. He is currently at Cardigan Mt. School in N.H. Oldest daughter, Christine (McClellan) has two girls and a boy and lives in Louisville where they have been for five years. Her husband is vice president of Expendicare, Inc. which operates a chain of nursing homes. Middle daughter, Jacqueline (Collins) lives in Holliston and has two children. Her husband is with Consolidated Elevator. Susan, the youngest daughter, graduated from University of Massachusetts two years ago and is a computer programmer at Polaroid in Cambridge. She moves to their new plant in New Bedford June 1 and will continue her programming, which controls the Foxboro equipment which in turn controls the mixing of film chemicals.

On a recent business trip to St. Petersburg I took **Earle Megathlin**'s address with me and told my sales representative that I wanted to look him up. To my surprise, I found the families had been good friends for ten years, so I ended up at Earle's lovely home and met his wife, Amy. Their children are married and moved away. Earle, Jr. is in consulting engineering at West Palm Beach and by the time you read this will be the father of two. Earle, Jr. graduated from Worcester Polytechnic Institute. Daughter Virginia (Mrs. Lincoln Warner) lives in Harrison, N.Y. and is married to an engineer with a New York scale company. Son Barclay graduated from Babson and works at I.B.M. in Boca Raton. He's the father of two little girls aged 2 and 3. Earle, since November, has been in the real estate business. He invites all '35ers to be sure to see him on arrival in Florida. He is associated with Humpe Roney, Seminole, Fla. This is quite a switch from his purchasing work at Raytheon and E.C.I., but he enjoys it and we know he will do well at it. I enjoyed my hour's visit thoroughly.

This month I shall be travelling to California on business again with time off to compete with **Ham Dow** in his Member-Guest Golf. You will have to wait until October to learn the results of that. And a happy June to you and yours.—**Allan Q. Mowatt,** Secretary, 61 Beaumont St., Newtonville, Mass. 02160

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These notes are due to reach you just about the time I hope you are attending the 35th reunion in the Berkshires. They are being written too early to give you a list of those planning to attend. . . . Some time ago I reported that **Semon** (Bunkie) **Knudsen** was planning to manufacture motor homes. His company, Rectrans, has already started to produce the "Discoverer" line in Brighton, Mich. We wish him well.

I regret to report the death on March 10 of **Philip F. Clark** of Norwichtown, Conn. He had retired as sales manager of the American Thermos Company in Norwich. He is survived by his wife, Elizabeth, two sons, a daughter and a step son and daughter. The Class extends sympathy to his family.—**Alice H. Kimball,** Secretary, 100 Memorial Dr., Apt. 8-6C, Cambridge, Mass. 02142 or P.O. Box 31, West Hartland, Conn. 06091

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Charles R. Gidley writes, "after working twenty-six years for Bethlehem Steel Co. and being involved in shipbuilding in various capacities, mostly in the New York area, I moved to Connecticut to work for General Dynamics Corp., Electric Boat Division, in 1963. I am in the Contracts Department, concentrating on submarine overhauls and conversions. Our two daughters are married and our only son is a junior at Colgate University and is definitely not the engineering type. I enjoy the more relaxed living and commuting in Connecticut." . . . **Perly Goodwin,** after 32 years of service, has recently left Acushnet Co. He is now president of the New Bedford Five Cents Savings Bank and is serving as director of the local Boy Scouts, United Fund, and St. Luke's Hospital. The Goodwins also are members of the grand parents club and as Perly writes, "Great fun and no responsibility." . . . **Nancy Klock** has been promoted to associate professor at the University of Hartford. Last summer she went to South America and toured Galapagos and then down the Amazon from Iquitos, (Peru) to Manaus, Brazil by dugout canoe, banana boat and speed boat. Nancy says it was great fun.

It is time to be thinking of our 35th reunion in 1972, and for each to make every effort to attend. **Dick Young,** our Reunion Chairman, is now located in England, but travels back to Cambridge, Mass. so that you will be hearing from him during the next year.

It is with regret that I report the death of **Leonard Schiff** on January 19, 1971. Leonard was a distinguished scientist and member of the Stanford University faculty. Our Class extends our sympathy to his wife, Frances, his daughter, Ellen and his son, Lee.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Curtiss Powell,** Assistant Secretary, Room 5-325, M.I.T., Cambridge, Mass. 02142; **Jerome Salny,** Assistant, Egbert Hill, Morristown, N.J.

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At just about the time this reaches you, I should be sitting with some of you at M.I.T. at the Pops. I quote from a bunch of goodies received. **Bernie Lement:** "I am now a director of Lement and McArdle Associates which is composed of private consultants engaged in product development, product safety and product liability. I find the technical aspects of product liability cases extremely interesting and have enjoyed my court appearances as an expert witness. My eldest daughter, Janet, will enter B.U. this fall and major in education." . . . **A. B. Levine:** "Have been ill—was hospitalized in Dubrovnik, Yugoslavia in October 1970 with a heart attack—did not learn much Croatian but with a dictionary at my bed and an understanding and patient staff I was well attended to." . . . **Cliff Nelson:** "Have returned to Maine after an interesting and profitable (scientifically, that is) year in Australia. Will be going to Brussels in August to take part in a symposium on the Electrical Field of the Heart. Wife is still teaching in Portland. We are triple grandparents. Also have son at Thomas College, Waterville, Maine."

Robert N. Elliott: "Present position—Chief Pilot, Rio Airways, a commuter airline in Texas." . . . **Jack T. Wilber:** "As a staff manufacturing engineer for Norton Co. in Worcester, Mass., I have occasionally traveled overseas to assist Norton International grinding wheel plants. In the past 12 years I have visited Brazil, Europe, United Kingdom, South Africa, and currently am scheduled for three months in Bombay, India."—**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney and Co., 140 Broadway, New York, N.Y. 10005

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I wonder how many alert readers of *Business Week* saw **Francis Sargent**'s photograph in an April issue, in a full-page advertisement by the Massachusetts Department of Commerce and Development. As Governor, Frank posed by one of Massachusetts' new highways, discussing his "Balanced Transportation Development Program." For the record, several other states featured full-page advertisements in the same issue of *Business Week,* but no other state could make the claim of having a governor drawn from the ranks of '39! Classmate Frank is also getting good headlines with Massachusetts' new "no fault" automobile insurance, with substantial savings in claims during the first few months of operation.

Don Severance forwarded news from **Harold Seykota.** Hal has moved from Florida to Madras, India, to help set up an $80 million fertilizer complex, owned 51 per cent by India and 49 per cent by Standard of Indiana. Hilda is joining him soon. Son Ed ('68) is with Hayden, Stone in New York, and Susan is married

and completing with honors her third year at the University of Iowa. . . . **Morgan C. Y. Sze,** manager of the Lummus Engineering Development Center at Lummus' International headquarters in Bloomfield, N.J., co-authored a technical paper at the 68th National Meeting of the American Institute of Chemical Engineers, announcing the development of a new process for upgrading by-products from an ethylene plant based on gas oil feedstock. Morgan's process converts pyrolysis gas oils into fuel oils through the use of mild and inexpensive hydrogenation.

Millard M. Brenner wrote that he is working as an independent consultant in cable television, and he lives in Philadelphia. . . . **Orlando de Aragon** noted to us that he continues as executive vice president of the Puerto Rico American Sugar Refinery Inc., and this year also was elected president of the Sugar Producers Association of P.R. "That keeps me quite busy." . . . My own news is that I have recently changed jobs and am now manager of Lo-Tow Conveyor and Switch-Cart sales for S.I. Handling Systems, Inc., of Easton, Pa. "Lo-Tow" is S.I.'s trade name for a remarkably successful and efficient in-floor towline system used for motor freight and air freight terminals, warehousing operations, and many manufacturing or production applications.—**Oswald Stewart,** Secretary, 3395 Green Meadow Circle, Bethlehem, Pa. 18017

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It is with great regret that I must report the death (from cancer) of **George H. Stoner** on February 28, 1971. At the time of our 25th reunion, George wrote, "Joined the Boeing Co. in 1941 and have risen from assistant superintendent of functional testing for the B-29 Superfortess bomber through a number of other important posts dealing with aircraft, missiles and space launch systems. In April 1958, became manager of Dyna-Soar program for Boeing and from there moved to the Boeing Company's participation in the National Aeronautics and Space Administration's Saturn program in August 1961. Was named general manager of the Saturn program in December 1961, and became a Boeing vice-president in 1962. Named assistant division manager, Launch and Space Systems, Aero-Space Division, in mid-1964." Subsequently, in 1969 George was associated with the Sunbeam Corp. and at the time of his death had returned to the Boeing Co. as senior vice-president—operations.

Norm Laschever has been appointed chief engineer at R.C.A. Aerospace Division. He will be responsible for the engineering division which is a major developer for government and space programs. Norm has been with the aerospace division since 1962. He and his wife Ruth and four children are residents of Sharon, Mass. . . . **Bob Hess** writes: "Am very happily settled in Stamford, Conn., after moving around a bit. Enjoying my career with a small computer outfit called I.B.M.—quite a switch for a chemist who has been in plastics most of his career. Besides a lovely wife, I have two boys: Tom, age 15 and Roger, age 10 (I started late!). While we hate to see this great ski season end, we are also looking forward to golf and tennis come warmer weather."

From **Don Monell** comes word: "Still practicing architecture and urban design in Gloucester, Mass. Have own office, doing mostly residential and small specialized industrial design throughout New England. Cruising friends please drop in at Eastern Point Yacht Club where we have good anchorage and clubhouse facilities. Eldest son recently got his soaring pilot's license and is about to enter college. Whole family involved in restoring classic cars; specialty at the moment is 1949 Willys Jeepsters. Got around a bit this winter with our ice-boat on Massachusetts and New Hampshire lakes." . . . Write your class secretary.—**Alvin Guttag,** Cushman, Darby & Cushman, 1801 K Street, N.W., Washington, D.C. 20006

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LAST REMINDER—In view of there being a reasonable chance that this issue will reach you before June 4, please accept this as the last reminder that your 30th Reunion is scheduled for June 4-6, 1971 on the M.I.T. campus, followed on June 6-7 by M.I.T. Homecoming activities. Our Class will occupy the comfortable and newly finished MacGregor Hall where **Ed Beaupre** will commence accepting registrations at 1:00 p.m. on Friday, June 4. We are privileged in having Dr. Paul E. Gray, M.I.T. chancellor-elect, for informal discussions with us at breakfast on Saturday morning, June 5. Please note that this reunion has been designed by your Reunion Committee to be as economical a way as possible for you to see and visit with your classmates in a vacation atmosphere including an abundance of cocktails, bountiful meals and a wide selection of social, athletic and intellectual activities. Our class president, **Ed Marden,** says that because of the large response by members of our class to previous mailings, a large attendance is assured, including a surprising number of children of classmates. Because of the brief time period allotted for this Reunion, you are urged to arrive here as early as you can after 1:00 p.m. on Friday.

Mr. **Paul G. Cushman** has been honored by an award from the General Electric Co. for being a co-inventor of an invention called coordinated voltage control for induction servomotors; this controls the voltage applied to an induction motor in a servo system so that precise control at all operating speeds and conditions is obtained. Paul is reported to be an innovator of long-standing in the company, with a number of previous patent awards to his credit. He is a member of Ordnance Equipment Projects at General Electric where he is a consulting systems engineer. As a consultant, he is involved in a wide range of department development projects. Paul joined G.E. on the company Test Program in 1941. In 1943 he was named to the Advanced Engineering Program, which took him to rotating assignments with the general engineering lab, and the industrial engineering departments. He was transferred to Pittsfield in 1957 where he worked on the Polaris and Poseidon programs at G.E. One of his patents last year was on an invention for strapped-down attitude reference for ballistic missile guidance. —**Walter J. Kreske,** Secretary, 53 State

St., Boston, Mass. 02109; **Everett R. Ackerson,** Assistant Secretary, 831 Cranford Ave., Westfield, N.J.; **Michael Driscoll,** Assistant Secretary, 63 Center St., Nantucket, Mass.

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As Kathy Sayre of the Review staff said in her note, "The cupboard is almost bare this month." But, here goes with our scraps anyway. And first, some (good) news from Southeast Asia. **Tan Eng Joo,** Chairman of the Rubber Association of Singapore, finds no conflict with synthetic rubber producers. He says "every ounce of natural rubber that is produced is bought and consumed." His company's concerns are tree ailments and insects, but there has been much success in fighting back. With the backing of the Rubber Research Institute of Malaya, which spends $5 million annually, the natural rubber industry has increased the latex production six-fold in the past 23 years. Malaysian rubber provides about half the nearly three million long tons used annually worldwide. Keep things bouncing, Tan! . . . **Ned Swanberg,** a former National Platform Tennis Association President, recently got something new to "bat around!" He's been installed as a trustee of the United Presbyterian Foundation in Philadelphia. The Foundation currently has invested funds exceeding $38 million, thanks to gifts and bequests. Ned, a vice president and partner of Scudder, Stevens and Clark in New York City, was a founder of the First Presbyterian Church in New Canaan, Conn. Good luck on and off the courts, Batman! . . . **Greg Gagarin** has joined The Gregg Company Ltd. of Hackensack, N.J. as vice president and will be moving to the "Garden State" some time this summer. Welcome to New Jersey, Gregg. You did mean "Alumni Club," didn't you, when you asked to be put on a "local club's mailing list?" The nearest Bunny Club is in New York!

The annual election of the Alumni Association of M.I.T. has **Tony del Valle** nominated as a member of the Board of Directors from District 7, Southeastern United States and Caribbean area. His record of accomplishments in the M.I.T. Club of Puerto Rico over the past years is a long one, including director, secretary, vice president and president. In other fields, more remunerative, he is President of Rodriguez and del Valle. Tony also serves as chairman of the Board of Caribe Crown Cap Corp., director of Central Coloso, Inc., chairman, Governor's Advisory Subcommittee on Housing, Director, Administration de Terrenos, and President, Associated General Contractors of America, Puerto Rico chapter. No time to tango, Tony? . . . **Walter Sutton** writes that his present position is now vice president, Industrial-Commercial Division and Marketing Manager of T.Y.E.E. Construction Co. (a Boise Cascade Co.) in Bellevue, Wash. A new "vue", eh Walt?

To close this enlightening column (compiled by Lois—edited by me) I report my election as a vice president and director of Butterworth Systems, Inc. in Bayonne, N.J. This wholly-owned affiliate of Standard Oil Co. (N.J.) sells and leases specialized equipment for tank-cleaning in both marine and land-based installations. It looks like there will be quite a bit of foreign travelling, if the first month on the job is any indication: started work on a Monday and next day went off to Europe for three and a half weeks! Got back in time to attend graduation services at Great Lakes N.T.C. where number three Kelly boy, Alan, completed his Recruit Training. It was a very stirring and memorable event, especially in these days when a John Phillips Sousa march doesn't appear in the "Top Ten!" If you don't want to hear any more about the Kelly family, send in some news of your own!—**Jack Kelly,** 34 Scudder Rd., Westfield, N.J. 07090

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The publication of this June issue of the *Review* will occur about a week or so after our 25th class reunion in Cambridge. Since the copy for this issue is written in mid-April we cannot include news about the reunion. It will be September before we can report on the reunion to those who were unable to attend. It appeared in mid-April that the Class would have difficulty in reaching its goal of a class gift of $400,000 by June 10. In these slower business times, sometimes things do occur at a later date than one would wish or plan. Please, therefore, send your contribution, for it will be most gratefully accepted even if June 10 has passed.

The receipt of postcard replies from the Class have been fewer in the last mailing and so we have little information on which to produce a column of class notes. I hope to gather more information at the 25th reunion, both from the reunion yearbook and personal interviews which will be used in future issues of the *Review.* . . . **Donald S. Cohen** sent a fine reply to our card from his home in Wyncote, Pa. After obtaining his engineering degree Don went to law school at night while working as a patent examiner in the U.S. Patent Office. Don received his J.D. degree in 1952 and was admitted to the bars of the District of Columbia and the Commonwealth of Pennsylvania. Don was then registered to practice before the U.S. Patent Office. He has been practicing patent law since then, both in private practice and as a corporate patent attorney. Don is presently a member of the patent department of R.C.A. in Princeton, N.J., and was recently promoted to senior patent counsel. . . . **Jim C. Ray** has written us on his doings the past years. Jim graduated from M.I.T. in Course XVI and has been with it ever since except for a brief experience in medicine in 1948-49. In 1958 Jim married Bettie and they went west to Lockheed Missiles and Space Co. where his work has been mostly in the field of satellite mission analysis and operations for assorted Air Force programs. Jim and Bettie have two little boys, Ron, 11, and Chris, 9. Jim's outside activities are tennis with Bettie, skin diving and campaigning for anti-war candidates.

James E. Bennett obtained his doctorate in medicine after graduation from M.I.T. In 1956 he married Ellen Mac Pherson and they now have four children, David, 13, Martha, 12, Thomas, 11 and Jonathan, 8. Jim is professor of surgery and director, plastic surgery, at Indiana University Medical Center in Indianapolis. He is immediate past chairman, Plastic Surgery Research Council and a member of the American Board of Surgery and American

R. J. Corless, '47

R. N. Creek, '47

Board of Plastic Surgery. . . . **John C. Johnson,** who obtained his master's and doctorate degrees at M.I.T. has been presented an award by the National Weather Service for his work in the field of meteorology. Dr. Johnson is a professor in the department of physics at Worcester Polytechnic Institute and is the author of a number of monographs and articles, as well as the college text, *Physical Meteorology*. . . . **David G. Hoag** has received another important and well-deserved award for his contribution to the navigation and guidance systems of the Apollo spacecraft. He has been honored by being named an honorary member of the British Institute of Navigation of the Royal Geographical Society.—**Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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This is a beautiful Easter weekend here in Cleveland. Yesterday, joined by son Bob, I played my first 18 holes of the year and as I tell myself, this year must be a better one on the links. . . . The clipping services advise that Professor **Samuel Mason** of M.I.T. was a panelist at a meeting held in New York by the Committee for Social Responsibility in Engineering. This group has been formed due to the "misuse of Technical Talent for Destructive or Frivolous Purposes while the lights are literally going out in our cities coupled with rising engineering unemployment." . . . **Bob Corless** has been elected president of American Olean Tile Co. of Lansdale, Pa. Bob had been vice president of merchandising operations.

Several of you made the effort to write a few words when sending in your alumni contribution. Probably the most gratifying is from **Aaron Newman** who acknowledges that he has never previously written. He is currently with Ebasco Services in New York as a project manager. He is responsible for the engineering and construction of two 800-megawatt steam power plants for Pennsylvania Power and Light Co. . . . **G. R. Welti** joined Comsat in 1968 as manager, Advanced Studies Lab. . . . **Bob Creek** in April 1970 was elected president of the Board of Education, Palatine, Ill. In March 1971 he was elected v.p.—administration for Union Oil Co. of California and in November 1971 was elected v.p. of West Shore Pipeline Co. I am assuming that Bob is performing the three jobs concurrently and is still in Palatine . . . **Adelaide Sundin** is very active making porcelain portrait bas-relief of children in the Washington, D.C. area. She learned this art as a special student in the ceramics department under Professor F. H. Norton.

Joseph Childs is manager of field product development of the Foxboro Co. in Foxboro, Mass. His hobbies are keeping up with Boy Scout and sports activities of his four teen-age sons and working on his 75-year-old house. . . . **Elwin Noxon** writes from Los Angeles that he is an executive v.p. and chairman of the board of Urban Projects, Inc. In this capacity he is engaged in the development of regional shopping centers and urban redevelopment projects of multi-use character for their own account. They also provide real estate development consulting services to corporate clients and landowners. . . . Thanks to you that have written and why don't many of you who have never written follow Aaron's lead? It won't hurt.—**Dick O'Donnell,** Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

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Spring seems finally to have arrived this day after Easter, but the first news note harks back to winter. **J. Thomas Toohy** reports that he is presently data systems development manager for I.B.M. in White Plains, New York and that while in a ski lift line on vacation in Verbier, Switzerland he unexpectedly met **John Kunstadter. . . . Herbert M. Federhen** checks in from the Defense Communications Planning Group in Washington. His job requires a lot of contact with industry and he says he has been holding minor reunions all over the country. So far, his principal complaint with Washington is the traffic, but he has found no takers to his recommended solution: pave the Potomac. . . . Dr. **Francis J. McCarthy** reports that he is doing psychiatric private practice in Wakefield, Mass. An unexpected occupation for someone who started out with an S.B. in chemical engineering. . . . **John D. Fogarty** reports a new job starting in January as engineering section head, digital processing, for I.T.T. Electro-Physics Laboratories, Inc., Columbia, Md. Jack's career has included stints with Philco Corporation, Honeywell, Univac, Elco Corporation, and General Atronics. He has worked variously on color TV, sonobuoy telemetry, control system and instrumentation design, data communications, pulsed-light and integrated circuit programs, and high-speed data transmission. In his current assignment he will have technical and administrative responsibility for the development and installation of special-purpose digital signal processing equipments.

From Long Binh, Vietnam comes word that Army Lieutenant Colonel **Gordon D. Shingleton** recently received his second award of the Bronze Star Medal for distinguishing himself through meritorious service in connection with military operations against hostile forces in Vietnam. He received his award while assigned as Chief of the Storage Division at the U.S. Army depot.

From Columbus, Ohio comes an announcement that **Richard A. Allen** has become manager, New Product Development Department, Industrial Nucleonics Corp. He will be responsible for planning and directing the research and development of new products. In addition to his E.E. degree from M.I.T., Mr. Allen holds a degree in physics from Amherst College. He lives in Worthington, Ohio with his wife, Barbara, and their three children. . . . Several clippings quote Dr. **William Haddon, Jr.,** President of the Insurance Institute for Highway Safety, as reporting that the flimsiness of American cars "appears to have worsened" with 1971 models, meaning that owners will pay an average of over $100 more than last year to repair damages to a minor front-end collision. In his testimony Dr. Haddon accuses manufacturers today of "picking the pockets of consumers by producing needlessly fragile cars."

A last-minute reminder that this year's donation to the Alumni Fund will count as part of our 25th reunion gift—a visiting professorship, for which we need close to $500,000. Please help, starting now. Best wishes to all.—**Frank T. Hulswit,** Secretary, 77 Temple Road, Concord, Mass.

R. A. Allen, '49

L. Stark, '50

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Loris M. Hailey, Jr. reports that he has joined Vought Aeronautics Company in Dallas as a senior specialist (avionics) in January of 1970, after eleven years with Martin Company in Orlando, Fla. He has specialized in computers for military systems since joining Convair in Fort Worth, Texas, upon graduation. Loris has two sons and two daughters—oldest 22, youngest 11—and a pretty red-head, Betty, for wife. . . . **Sanford C. Spraragen** announces the arrival of a new son, Joseph Martin, born on December 27, 1970. Sanford is chief, nuclear medicine at the Brooklyn Veterans Administration Hospital and Clinical Associate Professor of Radiology at the State University of New York Downstate Medical Center. . . . **Louis Stark** of Fullerton, Calif. has been elected a Fellow of the Institute of Electrical and Electronics Engineers. The honor, effective January 1, is the highest membership grade attainable in the Institute, the world's largest technical society. The election, achieved by invitation only, was based on Stark's inventions and developments in phased-array antenna technology. Louis is associate manager of Hughes Aircraft Company's communications and radar division. With Hughes since 1959, he has made numerous contributions to the company's advancements in the antenna field, especially in radar technology. He is credited with conceiving the theoretical analysis of planar phased array antennas which became the basis for nearly all current work in the field. Louis and his wife, Margie, live in Fullerton with their four children.

Norton Belknap reports that as of the first of the year, he has become the executive vice president and a director of Esso Europe. He continues to enjoy life in London with a lot of travel involved. . . . At a meeting of the Executive Committee of the Corporation held on January 8, **John F. McCarthy, Jr.** was appointed Professor in the Department of Aeronautics and Astronautics, beginning July 1, 1971. . . . **Ken McVicar** is assistant vice president of Bedford Operations at the Mitre Corporation in Bedford, Mass. Ken and his wife, Betty, have three children: Bruce, in his last year of junior high at Winchester High School; Douglas, a senior at Harvard; and Carol Ann, a freshman at Ohio Wesleyan University. Ken is an avid collector and hobbyist. One of his hobbies includes doing things for his boat such as removing the electricity and replacing it with kerosene lamps because they are more picturesque.—**J. T. McKenna, Jr.,** Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

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With the reunion so close (June 5 and 6 at the Provincetown Inn) and with so many of you kind people sending in notes on your reservation cards, I thought I would devote most of this column to remarks made by those indicating interest in the reunion. . . . **Bill Bley** is with Stone and Webster Engineering in Boston. William, Jr. 18, Linda 15 and wife Evelyn complete the Bley complement. . . . **Bill Callender** is president of a naval architecture and ocean engineering consulting firm, Bowen and Callender, Inc. in Houston. . . . **Roald Cann** is with Bryant Grinder Corp. doing a great variety of work including vibration studies and computer programming for problems related to grinding non-circular holes. Activities are extensive: nine years on the school board, chairman of an embryonic town planning board and—as you might guess, living in Springfield, Vermont—skiing. The Canns have a 150-acre ex-dairy farm which they are landscaping (with an old bulldozer). Rolly is tinkering with cars, TV, etc., and finally getting around to building some beds for Peter 11, Don 9 and Pam 7 who have been sleeping on mattresses on the floor up until now. Rolly says that all three children were planned and highly recommends his solution to family planning: he had a vasectomy. . . . Alida and **Charles Carpenter** spent the autumn at home fighting the flu. What kind of news is that? He didn't even tell us where he lives. Maybe he doesn't want us to catch it! . . . **John Conley** did make it—he was elected to the board of education in Matteson, Ill. . . . Virginia and **Bill Cox** are living in Gloversville, N.Y., have three children, ages 18, 17 and 11. The oldest is a girl, Kimberly. The other two, as you may have guessed, are boys. Bill is President of Karg Brothers, Inc.

Colonel **Francis J. Davis** was commanding officer of a signal battalion in Germany until last fall, and was then scheduled for either Washington, D.C. or Viet Nam. We have not heard of his actual destination at this point. The Davis's have five children, the youngest a daughter just one year old now.

Albert Erickson is still with G.E. in Lynn, Mass. His particular project is direct energy conversion and R. and D. work on oxygen generation for a space station. Al and Aurelia live in Wakefield and have four daughters, the oldest is 18 and at Pembroke College. Al reports that he still has the golf bug. . . . Gail and **James Eyer** are living in Tucson where Jim is Professor and Assistant Director of the Optical Sciences Center at the University of Arizona. They still maintain a permanent address in Dundee, N.Y.

Jean and **Bob Fagerstrom** have three children: boy, girl, boy—ages 10, 8, and 4. Bob is with Honeywell and they are living in Libertyville, Ill. . . . **Frank Fanelli** is chief of applied electro sciences at Electric Boat Division in Groton, Conn. If I am not mistaken, Frank has been there since graduation. He and Valerie have four children ages ranging 16 to 12. . . . **Randall Goff** is chief engineer, product research at Dresser Industries in Stratford, Conn. He and Elena have two daughters. . . . **Stanford Jones** is manager of development engineering for Raymond Engineering in Binghamton, N.Y. They manufacture narrow aisle electric lift trucks. . . . Major **Robert Lewis** is a chaplain in the U.S. Air Force assigned to L. G. Hanscom Field in Bedford, Mass.

John D. McGrew is the manager of Union Carbide's computer network. . . . **Arthur Orenberg** is still at R.C.A., Burlington, Mass. His project is an automatic monitoring and control system for all utilities at the new Disney World in central Florida. If you encounter air conditioning problems or a stalled monorail in Disney World, which opens this fall, you have one of your own classmates to blame.

I could not finish this issue without telling you about the Chief Forester of the Duquesne Incline. "Operation Garden of Eden" began in Melrose, Mass., in 1962 when **Antoni Tabak** organized a conservation program. Toni was an early comer in the conservation movement and the efforts to make people aware of the deteriorating state of their environment. In 1963, the Melrose Community Council accepted Toni's program which was subsequently endorsed by the Harvard University Arnold Arboritum, the Mass. Audobon Society, the American Forestry Association and the U.S. Departments of Agriculture, Interior and Commerce. "Up to this time," says Toni "I would have had trouble identifying a simple bush like forsythia." Toni moved to Pittsburgh in 1965 to join the marketing office of the International Nickel Co. It did not take him long to organize a clean up and beautification program in his new home community. Toni, his two older sons, and volunteers ranging from preteen to post 70, cleaned up the Duquesne Incline under Toni's direction to eliminate and tame wild grapes, gawky ailanthus trees and poison ivy and replace them with hundreds of trees and scores of scrubs and flowers. Why did he do it? "The Incline carries over 300,000 people annually and the site on which it is placed is visible from downtown Pittsburgh and miles away." All of this was done without federal, state, or city funds. I wish I could reproduce the pictures showing Toni at work on the hillside which commands a sweeping view of Pittsburgh's golden triangle.

Mike Tinkham was elected to the National Academy of Sciences. . . . And as **Frank Stefansson** wrote in his first communication with the class secretary since graduation, and as many of the others have concluded, and as I would like to emphasize: "I am looking forward to meeting my old classmates at the 1971 reunion."—**Howard L. Levingston,** Secretary, 358 Emerson Rd., Lexington, Mass. 02173; **Walter Davis,** Assistant Secretary, 346 Forest Ave., Brockton, Mass. 02402; **Paul Smith** Assistant Secretary, 11 Old Farm Rd., North Caldwell, N.J. 07006; **Marshall Alper,** Assistant Secretary, 1130 Coronet Ave., Pasadena, Calif. 91107

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At this time of year you are probably working in the yard, planting all manner of flora. I have no luck as a gardener; last year I put in a rock garden, and all the rocks died. . . . **W. Chandler Stevens** has started the Stevens Division of Universal Refrigeration, making parts for gas ranges. Chan reports that the Sea Scout troop that he advises has managed to obtain donations of four cruisers. First Lake Erie, then the world. . . . **George Ploussios** is now at the Wayland Laboratories of the Raytheon Co. He and his wife Cleo are settled in their new home in Andover with son Gregory. . . . **Elliot Swanson** and family are in Sydney, Australia, where Elliot is marketing large-scale 1100 series Univac computers. . . . The new chief of the Boating Safety Division of the U.S. Coast Guard's First District, based in Boston, is **Philippe C. Gaucher.** He reports to this duty from a two-year tour as commanding officer of the U.S.C.G.C. *Escabana,* a high endurance cutter assigned to ocean station duties and based at New Bedford, Mass.

At Wright-Patterson Air Force Base, Lieutenant Colonel **James A. Abrahamson** has been named director for the Maverick (AGM-65) System Program Office in the Aeronautical Systems Division of the U.S.A.F. A veteran of over 2600 flying hours and two tours in Southeast Asia, Colonel Abrahamson has served as a member of the National Aeronautics and Space Council staff in the executive office of the president, and he had been selected as an astronaut for the Air Force's Manned Orbiting Laboratory until the program was cancelled in 1969. He and his wife Barbara have two children. . . . **Roy Salzman** reports that he has taken on additional duties at Arthur D. Little, Inc., where he has been consulting on computer systems development and peripheral equipment market forecasts. He now serves on a half-time basis as A.D.L.'s Director of Information Services, managing a 360/40 installation with associated analysts and programmers. . . . If you attend Alumni Homecoming this year, be sure to drop me a note so that your classmates can learn about your activities.—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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Lloyd Brace recently joined the Boston Company as assistant to the president. His work will be to develop marketing programs. . . . **Tom Cleaver** officially received his Ph.D. from Harvard in March. . . . **Charlie Joyce** had both legs broken recently when hit by a taxi in Paris. They went thataway. . . . Did you know that **John Morefield** is also a gentleman farmer? Defined as someone who only spends weekends repairing fences and outbuildings with, hopefully, some time to ride his horses.

We are polling the Class for the best earthquake story. Thus far most results from people like **Mickey Reiss** who was shaken from his bed at the Century Plaza. The native California classmates had more permanent damage. We are also interested in a head count of those classmates who had a job change prompted by the 1969-1971 recession. Remember to get a copy of the results of the class questionnaire as compiled by **Phil Bryden.** Send in your $8 class dues, fill in the short questionnaire, then send it to us to add some length to these articles. This is a short article, but with luck the next one will have some news on activities of your fifty plus classmates and wives at the reunion. Then later in the year, the questionnaire news.—Cosecretaries: **Bruce B. Bredehoft,** 3 Knollwood Dr., Dover, Mass. 02030; **T. Guy Spencer, Jr.,** 73 Church St., Weston, Mass. 02193

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I'm writing this month's column from Moscow. Betty and I arrived here yesterday. We're traveling in our V.W. which is not an easy way but a rather interesting one for there is the opportunity to stop and visit many smaller towns and out-of-the-way places. The highlight of our trip, so far has been the beautiful choral concert we attended two nights ago in a small eleventh century cathedral inside the fortress of Novgorod. A group of about 30 Estonians sang liturgical and other

songs for almost two hours. The cathedral was packed—most people, including ourselves, stood for the entire concert including (Southerners, take note) for the singing of "Dixieland", which with "Swing Low, Sweet Chariot" and other American songs, concluded the performance.

Now for a few items from the mailbag which fortunately was replenished just before we left Helsinki. By the way, the mailbag with its newspaper clippings, letters, "terse notes", etc. was an item of great curiosity at the Soviet customs. . . . First from **A. Gollnick,** to whom I wrote for details upon learning of his impending marriage—"I'm sure I must qualify as the most unreliable and uncommunicative member of our class. My humble apologies for my recent silence. Your letter arrived as we were leaving to spend the holidays with parents. So I tenderly put it in a safe place—the location of which I promptly forgot! Maybe you can publish the news on our first wedding anniversary. To answer your questions: I was married on September 26, in Norwich, Vt. to Alice Robinson Brooke. Alice was director of student employment at Simmons College, and is now serving as a field director for their Science Center Fund Drive. So she is on the road a bit. My projects at the Aerophysics Lab got axed by the Defense Department, so after 15 years at M.I.T.—12 as a D.S.R. staff engineer—I headed for new pastures. Last June I joined Worthington Compressor and Eng'ne International as a member of their centrifugal compressor development group. It's a far cry from supersonic aerodynamics, but interesting and it's nice to have a job!"

Robert K. Boese writes: "I have recently returned home after spending 18 months in the Republic of Viet Nam as a General Surgeon with the United States Army. I have begun a limited private practice in general and vascular surgery in Manhattan. The majority of my time is spent at New York Medical College where I am organizing an organ transplant team. I am also a member of the teaching staff in surgery."

And finally, the terse note of the month is from **Jim Havender:** "I got married on December 27, 1970; my wife's name is Connie M." Good tax planning, Jim. More after 30 days in a Russian jail?— **Frederick L. Morefield,** Secretary, Tiirasaarentie 17, Helsinki 20, Finland

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The reunion is over by the time you read this but it is a couple of months away as I write it so its success or failure is a mystery to me just now. However the response to our first mailing is strikingly good thus far. We have substantially more interest in the 10th reunion than was shown five years ago. How the interest materialized into enthusiastic people will be the subject of my next column (if I'm re-elected to this post). The response to the reunion mailing included some personal notes about people's recent activities. **Lenny Coris** reported that his daughter Lisa was a year old last April and that his company, L. M. Coris and Associates is thriving. L.M.C. and Associates does financial planning for individuals and small companies. . . . **Susan** and **Lloyd Kannenberg** (Susan used to be S. Lippman) recently moved to Weston and are working at Lowell Tech and Boston State College (respectively) as physicists. Susan has been an officer of the Association of M.I.T. Alumnae for the last couple of years.

Emilia Ivanoff Nordtvedt writes: "After receiving an M.A. in clinical psychology from Stanford, I changed to early childhood education and have been teaching in the New York area for the last five years. I am about to receive my M.S. in early childhood education from Bank Street College of Education. I'm currently job hunting for the position of educational director in a nursery school. I joined Mensa last year." . . . **Aare Zonton** has a one-year-old son, Alan and was wondering about baby-sitting facilities during the reunion. . . . **Terry Langendoen** says he is the executive officer of the Ph.D. program in linguistics at the graduate center of the City University of New York. . . . And finally, finishing up the notes from the reunion returns **Avram Kalisky** wrote to notify us of his recent promotion to chief, Standard Laboratories Section of the Avco Measurement Standard Laboratories in Wilmington, Mass.

Through more standard channels **Al Klancnick** wrote "We had our third child —a girl—Kathi, join us in September 1970. Both boys, Mike and Steve, are enjoying their new sister (and *last* addition to the family). I am now employed by the Hi-Lo Manufacturing Corp., as a general manager." . . . **Donald G. Morrison** has been teaching in environmental studies and has been the director of the methods and analysis section of the Institute for Behavioral Research at York University in Canada. In July he leaves for Ibadan, Nigeria to become the visiting director of the Computer Center at the University of Ibadan. . . . **Michael Wechsler** is now vice president of mortgage and real estate at the Chemical Bank in New York.

Pete Bankson writes "After returning from my second tour in Vietnam last October, I was assigned to Combat Development Command at Ft. Belvoir, Va., where I am on a five–member board to draw up new guidelines for all army research and development. . . . A clipping from the Cleveland papers says that **Bill Lenoir,** our class astronaut, was talking up the Apollo Application Program in April 1970 (we really have a crummy clipping service). The article implys that Bill will be a member of some future sky lab mission so one of these days we will look up and see a spaceship called Beaver.— **Andrew Braun,** 464 Heath Street, Chestnut Hill, Mass. 02167

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Seeking solutions to the parking problems facing both the public and private sectors of American enterprise has kept yours truly regularly jetting a criss-cross pattern across these United States. I attempt to look up old M.I.T. friends during these excursions. . . . **Ted Sheskin** writes that as of April 1, 1971, he entered Penn State University for full-time graduate study in operations research in the Department of Industrial Engineering. . . . **Gerald Fleischli** is working on Medical Information Technology in the Department of Preventive Medicine at

the University of Nebraska Medical School, a self-defined specialty to remind him of M.I.T. . . . **George Wyman** is now treasurer and controller for Waldeu Research Corp. in Cambridge, Mass.

M.I.T. can be proud of **Elwyn Berlekamp** who has won honorable mention from Eta Kappa Nu engineering honor society as one of the nation's three outstanding young electrical engineers. This particular honor has been awarded for "his extraordinary contributions to the field of coding theory and his participation in community affairs." Berlekamp is with Bell Laboratories as a member of the mathematics research center in Murray Hill, N.J. He is the author of over 30 articles as well as a book, *Algebraic Coding Theory,* published by McGraw-Hill in 1968. An active member of the Sierra Club, participating in Foster Parents Plan, and teaching Sunday school are but a few of his many off-hours activities. He holds a master rating in the American Contract Bridge League, is a highly talented juggler, a champion swimmer, a composer of marching band compositions, an excellent chess player and plays softball for Bell Labs. Whew! Oops . . . forgot to mention that he is also fluent in Russian. One almost needs a nap even thinking about such mind-boggling activities.—**Gerald L. Katell,** Secretary, 122 North Maple Drive, Beverly Hills, Calif. 90210

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My entire inventory of news for this month consists of one clipping from an Alumni Fund envelope filled in by **Jim McGaughy, Jr.** Jim reports that he served aboard a nuclear submarine while in the navy, following which he received his M.S. in nuclear engineering at Stanford in 1969. In January of this year he was promoted to nuclear fuels engineer for Middle South Utilities. Jim now lives in New Orleans with his wife and one-year-old son. . . . And that, my dear classmates, is the news. Please, please lay some words on me!—**Ron Gilman,** Secretary, 5209 Peg Lane, Memphis, Tenn. 38117

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A last-minute influx of news from classmates keeps us going for yet another month. The column, however is still thin and depends on your inputs. That is a hint. **Lionel** (Kim) **Kimberling** is currently a captain in the air force doing semiconductor research at Hanscom Field in Bedford, Mass. Kim and his wife Linda have a two-year-old daughter, Rachel. . . . **Howie Ellis** is a private management consultant specializing in aspects of pollution control including planning government pollution control programs, helping industry solve pollution problems, and aiding companies seeking to provide pollution control products and services. . . . **David Curtis** is working with the Division of Naval Reactors of the Atomic Energy Commission in Washington. He is presently responsible for several core procurement contracts after his third job change within the organization in the last year. David will leave the navy in June and plans to stay with U.S.A.E.C. as a civilian. His wife Jan and son Steven are fine.

Thomas Hedberg is down to a three handicap in golf and is still single. (How many of us still in that category, I wonder?) Tom is doing graduate work in operations research at Penn and working for a small O.R. consulting firm, Ketron, Inc. . . . **Richard Schwarz** completed his Ph.D. in chemistry at Duke early in 1970 and remained for seven months as a post-doctoral research associate with the late Dr. C. R. Hauser. Since September, Richard has been a research scientist with Firestone Tire and Rubber in Akron. . . . **Terry Dorschner** has finished his Ph.D. work in electrical engineering at the University of Wisconsin. He plans post-doctoral work at the Institut für Hochfrequenztechnik of the Technische Universität, Braunschweig, West Germany. . . . **Ralph Cicerone** is continuing his post-doctoral research work at the University of Michigan, in atmospheric and space physics.

Finally a happy summer to you all. My summer activity is hiking and backpacking in the mountains of New England. Why not drop a note and tell me about your summer plans.—**Steve Lipner,** Secretary, 940 Belmont St., Watertown, Mass. 02172

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This month we make up for the last few lean columns. The stack of mail from the *Review* office was larger than usual. I met several classmates at an M.I.T. seminar in Anaheim. And, believe it or not, three letters were addressed to me in Fort Collins! The first of these earns the Hero-of-the-Month Award for **Tom Van Tienhoven** for being the most travelled classmate. I'll let him tell his own story: "My wife and I have been running around quite a bit for Bechtel International (actually she just follows me!), and we haven't been settled for a year now. We hope Germany will be our home for the next couple of years. Last year we spent three months in Acapulco finishing a 500-room hotel for American Airlines. This was interspersed with survey trips to Rio de Janeiro and Buenos Aires (three times, which also happens to be home). Then back to New York for one month before Christmas with our families in Argentina. Then another month in New York before leaving the U.S. in early February with a destination of West Berlin where I was going to be resident manager on a bank building project, but after two weeks, the Germans changed their minds and decided to build it themselves. We then came to Frankfurt where Bechtel is finishing the 300-room addition to the Frankfurt Intercontinental, making it Europe's largest upon completion in September. In October we're going to Munich where I'll be resident manager on one of two hotels being built there. We will be ideally located for the forthcoming Olympic Games and extend an invitation for classmates who might be in the vicinity to get in touch with us. Funnily, I've crossed paths with very few M.I.T. alumni. I guess the construction industry is not that popular with them, although I personally wouldn't change for anything in the world."

On the third of April **Carl Jones** and Nory Haas '69 were married. They are now in Gulfport, Miss., where Carl is due for an early discharge from the navy at the end of April. After that, they plan to travel a lot, with no definite plans for jobs or future home, other than it "probably" being on the sunny West Coast. . . . Barbara and **Carl Uhrmacher** moved to Columbia, the new city, when Carl joined F.M.C. in Baltimore. They are both very concerned with pollution control and are "involved with several groups which are working on county and state levels to do something about the mess we're making of our environment." To fill their new home they have a dog, cat, and an ever-expanding art collection. Barbara passes on the word that **Harold** and **Ann (Kazanow) Dershowitz** live in Philadelphia and have at least one child. . . . **Jon Meads** has just moved to Lake Oswego, Oregon, where he has taken a position as supervisor of software product development for Tektronix Information Display Products. . . . **Alan Ford** was last seen heading for Nashville to start a communal farm.

My trip to Anaheim for the M.I.T. seminar on "How to Start and Operate a Small Business and Make It Grow" netted contacts with the following. Barbara and **Steve Kurtin** are living in Pasadena with their little six-month-old. Steve works for Autoscribe Corp. . . . **Rich Lucy** is still with McDonald-Douglas, although he appears ready to jump into the plastic bathroom fixtures business. . . . **Paul Branstad** is manager, economic systems for Litton Industries, where he supervises costs on large Litton projects.

Peter Lindes works for Hewlett Packard in Palo Alto where he heads a software systems group. . . . **Joe Shaffery** is now working for Mattel Toys in Hawthorne, Calif. Theresa and Joe are expecting a second toy customer in April, 1971. . . . **Robert Akeson**'s first child, Mark, was born August 29, 1970. . . . **Dave Root**'s second child, Benjamin, joined an older sister Erica (6) last April. Dave and family are living in Baltimore.

The doctoral mill continues to grind. **Al Steinman** will graduate from Stanford Medical School in June and will intern at the Mayo Clinic in a mixed medicine-surgery program. He completed a course in athletic medicine during which time he served as assistant team physician to the Rose Bowl champs. . . . **Bill Steffy**

is currently an impoverished graduate student in chemistry at Wayne State University. . . . **Joe Bravman** expects to receive his Ph.D. from Cornell this June and is now working for Cayuga Associates in Ithaca. The company manufactures GaAs microwave oscillators. His wife Susan is a counselor-teacher at Tompkins-Cortland Community College.

Finally, **Uday Sukhatme** will get his Sc.D. in theoretical elementary particle physics from M.I.T. in September, after which he will join the Physics Department at the University of Washington, Seattle.

Nicholas Negroponte received the most attention at a recent museum exhibition on computing software. His work was "Seek", involving the interaction between a computer and a colony of gerbils, with the objective of having the computer deduce the architectural needs of the gerbils from their behavior in rearranging an aggregation of blocks.

Now in his fourth year as a management consultant at Harbridge House, Inc., is **Dave Lampert** who specializes in mathematical models of transportation systems. . . . **Hal Helfand** was discharged from the Public Health Service in June and spent the summer digging the scene in New York with his wife. After three months travel in Europe, they moved to San Francisco where he is a systems analyst in the cost engineering department of Bechtel Corporation.

After three years working for M.I.T. on Project INTREX, **Steve Teicher** is presently employed as a project engineer by Digital Equipment Corporation in Maynard, Mass. He and a fellow engineer recently designed a peripheral floating point processor that speeds up mini-computer arithmetic by a factor of 40. Steve, wife Debby, and daughter Jennifer live in a newly purchased house in Hudson. . . . **Ronny Perlman** has been teaching psychology, French, calculus, and Spanish at the Hesbjerg Peace College on the Island of Fyn, Denmark, where the college is located in an old castle. Ronny had the pleasure of living in the dungeon there! After leaving M.I.T., he acted in Boston and taught in the public school serving a New York state orphanage. He is now starting a school of arts, languages, farming, and science for teachers and students from the Boston area. The school is located on an ocean-side 300 acres in Nova Scotia. . . . Cheers!—**Terry J. Vander Werff,** Secretary, 2049 Manchester Dr., Fort Collins, Colo. 80521

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I recently received the letter that **Bob Howard** promised he would write during his visit to San Francisco. The letter is quite helpful since it contains info on some classmates about whom I have not written. Bob writes: "Mr. and Mrs. **Richard Bronowitz** are expecting a baby (their first) in June. Rich has been working on his Ph.D. in math at University of Florida. He is presently working full time on his dissertation. . . . **Robert Shishko** is working in the economics department at Rand Corporation in Santa Monica while finishing his dissertation for a Ph.D. from Yale. Incidentally, he co-authored an M.I.T. Press book on the M.I.T. libraries and received an award from O.R.S.A. for a paper on cost-benefit analysis. . . . **Arthur Hellman,** who started with our Class at the Institute, then joined the marines after our sophomore year, has returned and is now majoring in architecture. He spent 27 months in combat in Viet Nam—part of it in a ground unit and the other part flying observation planes. He was mustered out of the service after four years duty as a first lieutenant. He hopes that some of his old friends will look him up if they make a trip to Boston. . . . **Steve Alter,** who has been teaching school for the last two years, hopes to start on a Ph.D. in management in the fall. . . . **Eric Coe** will graduate from Columbia Medical School in May. He is planning to spend two months this summer in Europe playing in tennis tournaments, then come back and start his internship. As for me (Bob Howard), I am presently in the army working as a systems analyst for the Combat Development Company at Fort Belvoir, Va., which is about 15 miles south of Washington, D.C. I expect to be released from the army in September, but haven't yet formulated my plans. **Harvey Golomb** also has been working here at Belvoir. He is a first lieutenant in the Medical Corp and has been working on medical information systems in the Office of the Surgeon General. That's about all the news. I'll try to let you know the next time I'm coming to San Francisco." Thanks, Bob, for writing about half this month's news.

Pasquale Confalone received A.M. and Ph.D. degrees from Harvard in March. . . . In a government economy move, 825 people lost their jobs at N.A.S.A. in Technology Square. **Bruce Ressler** was among those immediately hired the following day by the new Department of Transportation center in Kendall Square. Bruce is working on a computer aircraft navigation system. . . . **Henry Heines** will be receiving his Ph.D. in chemical engineering from the University of Illinois this summer. He hopes to then go back east. . . . **David Garbin** was forced to leave M.I.T. by his draft board in November, 1968. He enlisted as an officer in U.S.A.F. Since August, 1969, he has been in Air Force Communications Service doing worldwide evaluation of wideband radio relay systems. . . . **David Schramm** received his Ph.D. in physics from Caltech in January. He will be at Caltech until September, 1972, as a post-doctoral research fellow in physics. . . . **Fred Anderson** and the former Maryann Blaisdell were married July 11, 1970. They traveled in Appalachia on their honeymoon; they have also covered the Midwest looking for a good place to live.

Marc, son of Jane and **Ron Gomes-Casseres,** weighed in at 7 pounds, 10 ounces on February 18, 1971. Rumor has it that he has curly red hair. . . . Jackie, Matthew (22 months), and **Sheldon Bayer** are residing in the mid-Pacific on the island of Midway where Shel is an ensign in the U.S.N. He is transportation officer and is responsible for the maintenance of the station's vehicles including the main mode of transportation—bicycles! They are expecting twins. . . . **Pete McMorran** writes from Stockport, England: "I finished my S.M. in mechanical engineering at M.I.T. in June, 1968. Then I came straight to Manchester where I've been working hard on multivariable control systems. My Ph.D. thesis is now in full swing, and I should be away in June. I managed to write a few papers along the way, with a couple more in the pipeline, and I've a huge stock of unexplored ideas stored away for a quiet day. I'll soon be joining Alcan in scenic Arvida, Quebec, as a research engineer, after a brief visit in Montreal to make sure that it's still there. And now back to the transfer function matrix . . . cheers."

John Schwarz sent some family news. His wife Nancy (former Nancy Nirenstein, Simmons '69) gave birth on March 27 to their first child, a 7 pound, 11 ounce boy, Eric Stanley. John will soon receive his M.D. from U.C.L.A. School of Medicine and will be doing a straight medical internship at Washington Hospital Center, Washington, D.C. They are planning to live in Silver Spring, Md. On July 1, 1972, John will begin a four-year residency in ophthalmology at Boston University School of Medicine.—**Jim Swanson,** Secretary, 774 Channing Ave., Palo Alto, Calif. 94301

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It is April 7 as I write this, yet all of scenic Cambridge is covered with snow. Actually there is a simple reason for this phenomenon—I took the snow tires off the car last weekend! We really don't have too much mail this month, so why don't you help out and drop us a line.

"The Selling of the Pentagon"
The above named C.B.S. documentary has been in the news a lot recently, especially after Mr. Agnew's review of it. One activity that was mentioned was the army's program of hometown press releases. I usually receive many such items from the air force, but very few from the army and navy. However, this month the army and the navy have lived up to C.B.S.'s claims and furnished two stories. First, I shall print in full an item from the Army Home Town News Center, Kansas City, Mo.: "Ft. Lee, Va. (AHTNC) March 8—Specialist Four **Henry C. Banach,** son of Mr. and Mrs. Jack J. Banach, 4000 Madison Ave., Bridgeport, Conn., graduated with honors from a subsistence specialist course recently at the Army Quartermaster School, Ft. Lee, Va. During

Henry C. Banach, '68

the eight-week course, he was trained to receive, store, issue and ship food supplies. He also received instruction in the Army supply system, materials-handling equipment and commissary operations. Spec. Banch (*sic*) is a member of the 665th General Supply Company, U.S. Army Reserve, Bridgeport, Conn. He received his B.S. degree in 1968 from Massachusetts Institute of Technology, Cambridge. His wife, Frances, lives at 1525 Central Ave., Bridgeport."

From the Public Affairs Office of the Naval Air Systems Command we hear that Lieutenant (j.g.) **John Patterson** is now assigned to that command in Washington as an Air-to-Air Missile Officer, which involves the engineering and procurement of such missiles. . . . We got a nice letter from Joanne ('70) and **Art Cole.** Art has now been promoted to first lieutenant in the air force and was transferred to Rhein/Main A.B., Flugharon Frankfurt, Germany where he is with the Traffic Control Section of the 630th Military Airlift Support Squadron. Art supervises the loading and unloading of all freight arriving there. They are living in the town of Braunshardt, about 15 or 20 km. south of the base where only a few other American families live. Their only problem seems to be that Germans who live off the beaten path seem to speak English as well as Americans speak high school French, so they are desperately trying to learn German. Joanne reports that she finished her degree requirements while Art was at McGuire A.F.B. by joining the wave of coeducation at Princeton.

Lieutenant **Howard Richards** is now serving a combat tour in Thailand as an F-4 navigator and expects to rotate to the States or Europe in July. Howard reports that Lieutenant **Steve Richards** is also an F-4 navigator there. . . . Finally, **Bill Ohm** writes "Made it through two years at defense plants with my 2-A. Finally my number (224) was passed and I'm FREE!" He is now studying for an M.B.A—. at Harvard. . . . **Dana Sheldon** is stationed at Pensacola NAS, Fla., Lieutenant **Phil Jhin** is at the Redstone Arsenal, Ala. and Sp4 **Philip Sikes** is stationed at Ft. Hood, Texas.

On a lighter note, on November 13, 1970 Mr. and Mrs. **Jeffrey Altman** became the proud parents of a boy, Matthew David. . . . **Constantine Karalis** is now Assistant Professor of Architecture, in the Department of Architectural Studies, Rhode Island School of Design. . . . **Steve Sydoriak** and his wife Barbara have moved to Los Alamos where he is on the staff of the physics division of the Los Alamos Scientific Laboratory. . . . We recently met **Ann O'Reilly** at an Association of M.I.T. Alumnae luncheon at Endicott House. She is working as a programmer at Arthur D. Little and is spending a lot of time on an assignment in New York City. . . . Would you believe that it's now three years since graduation. It's enough to make you feel old. Have a nice summer.—**Gail** and **Mike Marcus,** Eastgate Apt. 16A, 60 Wadswoth St., Cambridge, Mass. 02142

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I'll be clerking for the law firm of Wyman, Bautzer, Finell, Rothman and Kuchel in Beverly Hills, Calif. this summer. I would like to hear from any of my classmates who are in the Los Angeles area. Perhaps we can even talk about the virtues of Southern California as opposed to the relative virtues of the eastern seaboard. It'll be my first trip west of the Mississippi River and will give me the chance to size up the West for future possible permanent residence and employment. Let me know what you think. . . . I have received only a few letters during the past month. Take a break and tell the world what you've been up to as recorded by our friend the blue dwarf in this column. In this business, no news is no column.

Robert (Sandy) **J. Randall** has finished his second year with General Dynamics, Electric Boat Division, in Groton, Conn. He is kept company by his wife Donna, his dog George, and "good old Harry" the turtle that lives under the sofa. While working in the hydrostatics section of the naval architecture department, Sandy and Donna are also busily engaged in the process of purchasing a 103-year-old farmhouse. The renovating which the farmhouse will need will slow down some of Sandy's sailing. In his letter Sandy added the following information about classmates. . . . **Clyde Shiraki** returned from Viet Nam in May. His first assignment as a navy ensign was aboard the only U.S. naval commissioned vessel in Cambodia. . . . **Frank McCue** has left for two years of duty in Hawaii. Prior to this assignment Frank was on a year tour at Winter Harbor, Maine, where he was stationed in Acadia National Park. . . . As a general note, Sandy concludes his letter, "Chris Ryan, Bob Davis, Dan Dudgeon, Rick Barnes, and Dave Felton are rumored to be alive and well, as evidenced by recent letters. But whatever happened to Ron Skellenger?" Thanks for the news, Sandy.

John B. Black entered the U.S. Army in September, 1970, as a second lieutenant and attended the Signal Officer Basic Course at Fort Gordon, Ga. He then proceeded to the Automatic Data Processing Plans and Operations Officer Course at Fort Benjamin, Harrison, Ind. In May, John took up a systems analyst position at his permanent station of Sacramento Army Depot, Calif. During these maneuvers, John married the former Miss Rita Beck of Miami, Fla., a psychology major graduate of Smith College, on December 28, 1970. They met during the summer of 1970 when they both took a T-group course at Harvard University. As a member of the Concerned Officers Movement, John is working to change the army from within.

George Varga has received his S.M. in flight transportation after finishing the five year program at M.I.T. He is currently enrolled in the first year class at Harvard Business School and is engaged to Miss Beverly Skotnicki, formerly of Boston University, who is teaching first grade in Quincy. . . . **Mike Devorkin** was selected as a finalist in the Harlan Fiske Stone appellate competition at Yale Law School. . . . **Lenore** (Nory) **Haas** exchanged wedding vows with Carl Jones, '66, on April 3, 1971. After the wedding, Nory and Carl headed to Gulfport, Miss., where Carl was scheduled to get an early discharge from the navy at the end of April. They have no definite plans for jobs or future home (probably the sunny West Coast), and expect to do some traveling following Carl's discharge, hopefully getting to Boston for Carl's 5th reunion in June.

Irene M. (Platzblatt) Pepperberg received her A.M. degree from Harvard University on March 8, 1971, when mid-year degrees were awarded. . . . **Greg Kast** married the former Miss Linda Breen on October 24, 1970.—**Richard J. Moen,** Secretary-Treasurer, 412 Hastings Hall, Cambridge, Mass. 02138

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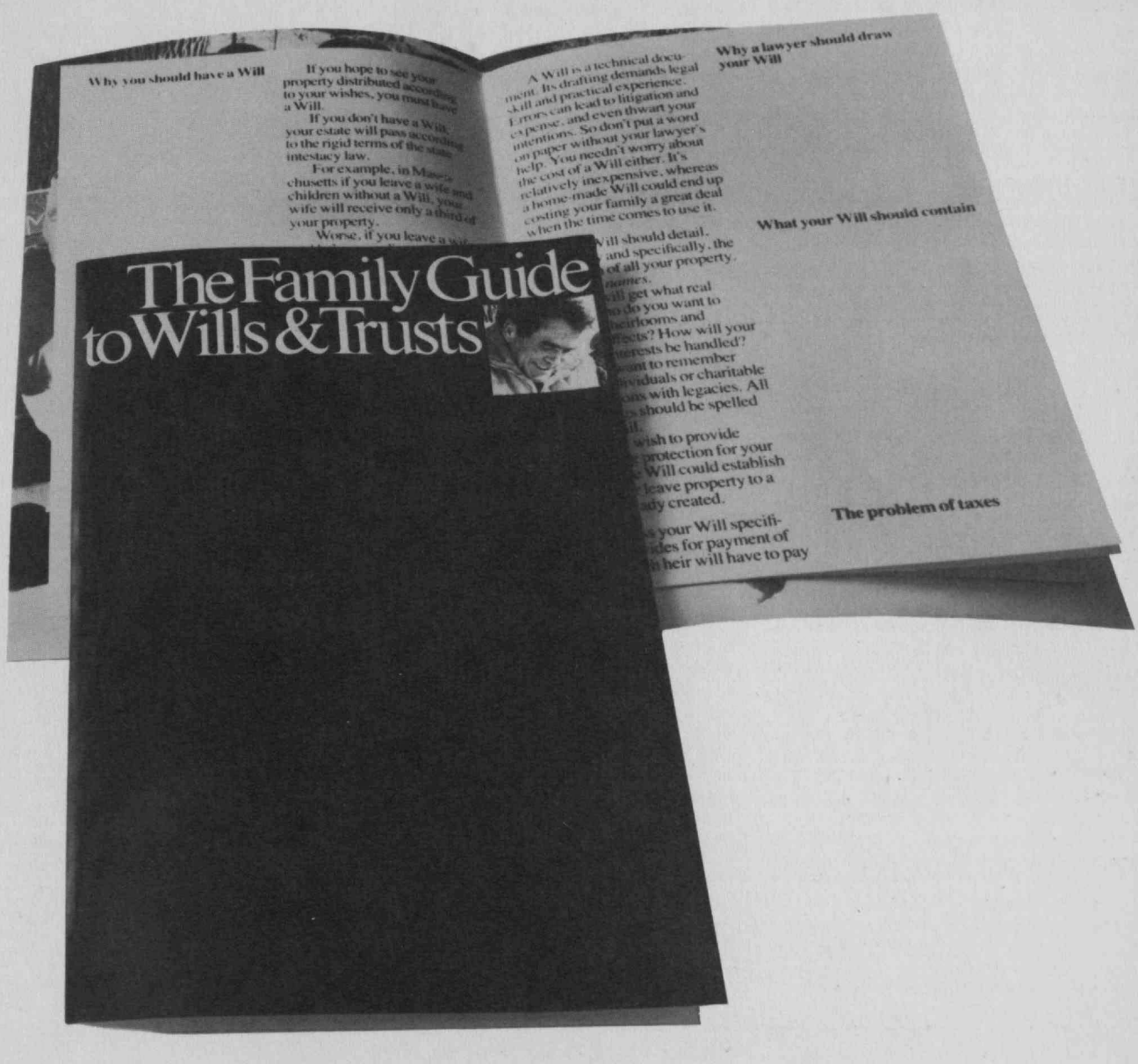

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